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LEWIS STEPHEN PILCHER, M.D., LL.D.
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With the Collaboration of
SIR WILLIAM MACEWEN, M.D., LL.D. of Glasgow
SIR W. WATSON CHEYNE, C.B., F.R.S. of London

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ANNALS *of* SURGERY

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A STUDY OF ANTE-OPERATIVE AND POST-OPERATIVE BLOOD COUNTS IN NON-INFECTIVE SURGICAL CONDITIONS

BY FRANK L. MELENEY, M.D.
OF NEW YORK
HOUSE SURGEON, PRESBYTERIAN HOSPITAL.

(Under a Grant from the Harriman Research Fund, College of Physicians and Surgeons, Columbia University, N. Y. C.)

THE blood count in acute infective surgical conditions has been of much interest and of great importance in diagnosis and prognosis for some time. Sondern [1] demonstrated its value beyond question by many observations and produced his "resistance line." His findings were very soon confirmed by many observers—Gibson,[2] Wilson,[3] Lampé,[4] and others.

The phenomenon of post-operative leucocytosis which occurs in those cases which have no acute infective process going on, although less frequently observed, should be of interest both to the surgical pathologist and to the operator who endeavors to minimize the injury of an operation.

A number of observers—Chadbourne,[5] Da Costa and Kalteyer,[6] Cabot, Blake and Hubbard [7]—found, some years ago, that there is a leucocytosis following operations under anæsthesia. Each group of men, however, has given a different explanation for the phenomenon. One attributes it chiefly to the anæsthetic; another, to the concentration of blood; a third, to the operation. None of them subjected the phenomenon to the ultimate analysis for obvious reasons—the causative factors may be so numerous that it is impossible to subject human beings, or even animals, to one factor at a time and observe the result of each. A study of any single case, for the same reasons, leads one into a maze of difficulties. It is only by taking a large

TABLE I

LIST OF OPERATIONS STUDIED

10 inguinal herniæ repair	1 amputation of toe
7 chronic appendicectomy	1 removal joint-mouse
5 dilatation and curettage	1 repair fracture of patella
3 hysteropexy	1 open reduction dislocation of shoulder
2 hysterectomy	1 colpoplasty
2 partial thyroidectomy	1 partial excision of omentum
2 partial phlebectomy for varicocele	1 ovarian cystectomy
2 Lane plating	1 closure fecal fistula
1 femoral hernia repair	1 laminectomy
1 excision lipoma of vulva	1 craniotomy
1 excision papilloma of breast	1 Percy cautery
1 epididymectomy	1 axillary dissection
1 amputation of leg	1 gastro-enterostomy

TABLE II

WHITE CELL COUNTS—51 CASES

Day of count		A. O.	P. O.	1	2	3	4	5	6	7	8	9	10	11	12
Case No.															
1	L. S.	9,300	20,650	18,750	14,550	10,100	12,100	9,100	.....	.....	.....	.....	.....	.....	.....
2	G. C.	9,150	20,200	16,550	11,700	11,100	8,350	8,750	8,550	.....	.....	.....	.....	.....	.....
3	J. B.	7,150	20,800	17,550	12,200	10,150	9,100	6,050	.....	.....	.....	.....	.....	.....	.....
4	*R. M.	13,400	26,600	16,550	12,800	10,350	9,700	11,550	13,200	11,350	9,100	.....	.....	.....	.....
5	†J. Q.	10,600	17,800	20,600	20,900	15,800	15,900	17,600	19,650	10,050	.....	14,500	11,900	.....	9,950
6	A. L.	11,450	20,050	20,050	12,400	14,000	11,350	9,550	9,500	.....	.....	.....	.....	.....	.....
7	M. L.	8,700	17,700	11,550	12,450	11,650	11,900	8,450	.....	.....	.....	.....	.....	.....	.....
8	†M. D.	8,100	9,900	7,100	7,450	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
9	W. H.	14,150	25,650	21,800	17,650	12,600	12,300	12,800	12,750	13,600	14,150	.....	12,000	.....	13,050
10	E. K.	14,350	21,750	35,700	14,200	11,100	9,200	7,400	.....	.....	.....	.....	.....	.....	.....
11	‡M. A.	19,400	28,950	27,450	29,600	20,000	21,900	19,750	18,550	15,400	.....	.....	.....	.....	.....
12	A. T.	11,150	21,350	15,000	16,800	8,300	8,800	.....	.....	.....	.....	.....	.....	.....	.....
13	H. S.	9,900	27,750	16,200	17,550	12,250	10,700	12,700	10,150	7,300	.....	.....	.....	.....	.....
14	†H. E.	8,800	29,050	14,800	15,050	9,050	9,650	10,400	15,800	11,100	14,000	13,000	.....	8,800	.....
15	E. D.	11,550	18,350	13,500	11,350	15,650	10,700	11,300	.....	.....	.....	.....	.....	.....	.....
16	H. S.	9,050	19,000	15,000	11,350	9,550	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	A. F.	6,250	18,100	9,050	9,800	8,500	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	*J. D.	12,550	15,050	13,350	10,000	8,250	8,400	.....	.....	.....	.....	.....	.....	.....	.....
19	*W. P.	13,950	23,200	19,800	16,250	9,950	7,150	.....	.....	.....	.....	.....	.....	.....	.....
20	†J. G.	9,300	15,700	16,500	15,350	15,200	16,000	11,700	11,650	16,350	.....	.....	.....	.....	.....
21	†H. O.	9,500	21,000	11,750	9,600	6,700	5,600	.....	.....	.....	.....	.....	.....	.....	.....
22	A. N.	6,000	20,800	17,400	13,500	11,000	12,050	10,100	9,600	9,300	9,100	7,250	.....	.....	.....
23	S. L.	8,250	17,100	11,000	11,350	9,050	11,400	10,400	14,250	9,400	.....	9,900	.....	.....	.....
24	A. S.	10,300	33,050	17,700	16,600	13,400	12,400	10,450	10,250	10,650	.....	10,650	.....	10,950	.....
25	M. K.	10,500	14,600	11,950	11,600	7,450	8,200	7,950	8,050	.....	.....	.....	.....	.....	.....
26	L. Z.	9,100	16,600	10,200	10,800	8,500	5,900	.....	.....	.....	.....	.....	.....	.....	.....
27	R. B.	9,250	30,000	16,950	14,700	9,900	11,000	11,800	8,600	8,300	.....	.....	.....	.....	.....
28	E. K.	12,150	13,100	12,250	11,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	H. S.	9,000	16,950	13,300	10,150	7,950	7,400	.....	.....	.....	.....	.....	.....	.....	.....
30	*N. N.	13,600	18,050	22,700	15,800	13,550	10,700	10,800	12,150	10,800	14,600	12,200	8,600	.....	.....
31	B. W.	6,450	14,200	9,850	7,300	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
32	G. S.	8,000	14,750	10,700	10,200	10,100	8,000	.....	.....	.....	.....	.....	.....	.....	.....
33	F. S.	7,100	14,000	8,900	9,200	8,050	.....	.....	.....	.....	.....	.....	.....	.....	.....
34	E. M.	8,150	20,600	12,850	12,500	11,600	8,300	8,750	.....	.....	.....	.....	.....	.....	.....

35	M. E.	13,050	32,750	20,400	15,950	13,250	10,150	11,700	14,050	10,700	11,650	12,750	.....	.....	.....
36	†J. B.	6,300	17,300	.....	10,800	6,500	.....	.....	.....	.....	.....	.....	.....	.....	.....
37	H. M.	11,250	17,500	12,550	6,700	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
38	H. C.	12,200	37,100	21,150	16,050	17,300	13,600	16,700	15,500	10,000	10,400	11,850	10,900	.....	.....
39	*C. N.	12,150	19,500	16,250	12,600	16,700	11,000	8,350	.....	.....	.....	.....	.....	.....	.....
40	L. G.	11,900	15,100	13,900	12,200	17,700	13,350	10,650	.....	.....	.....	.....	.....	.....	.....
41	*J. S.	13,100	32,600	19,000	20,100	16,400	12,000	.....	12,700	12,550	12,500	.....	.....	.....	.....
42	J. R.	10,100	21,150	19,800	12,000	10,200	10,650	.....	12,950	8,500	.....	.....	.....	.....	.....
43	M. K.	11,300	22,500	21,650	16,650	.....	9,800	8,200	.....	.....	.....	.....	.....	.....	.....
44	†B. A.	8,800	17,300	13,000	.....	12,200	14,500	12,250	12,250	10,800	12,250	14,250	11,700	8,400	.....
45	I. S.	10,550	24,950	20,000	14,400	13,000	11,000	8,900	7,400	.....	.....	.....	.....	.....	.....
46	†A. S.	9,600	15,950	12,900	10,900	11,450	13,600	9,150	8,050	.....	.....	.....	.....	.....	.....
47	H. N.	8,900	26,300	16,300	17,050	10,900	9,300	7,850	.....	.....	.....	.....	.....	.....	.....
48	†B. Z.	9,600	19,050	16,650	12,500	11,600	.....	.....	.....	.....	.....	.....	.....	.....	.....
49	J. B.	6,300	17,050	11,350	11,700	7,900	.....	.....	.....	.....	.....	.....	.....	.....	.....
50	A. E.	10,250	27,400	17,450	16,400	11,800	9,650	10,000	10,200	11,400	10,900	.....	.....	.....	.....
51	M. A.	10,250	25,250	17,650	15,700	12,450	12,300	10,350	10,550	.....	.....	.....	.....	.....	.....

* Large herniæ.
† Infected.
‡ Carcinoma of the uterus with degeneration.

number of cases which have some one thing in common, that this highest common factor, so to speak, can stand out prominently and the individual variations be reduced to a minimum.

Plan.—With the purpose of finding out the extent of post-operative leucocytosis in man and at the same time arriving, if possible, at some conclusions regarding the prime factors in its production, 51 cases were studied in the wards of the Presbyterian Hospital. These cases were chosen at random, the only cases not accepted in the series being those in which an acute infection was present before operation or a marked infection expected after it. A glance at Table I will reveal the diversity of the cases studied.

In planning the study, I tried to consider all of the factors which might have a bearing on the subject, in the periods before, during, and after operation. In each case the following data were obtained—the age, sex, and type of individual; the character, length and severity of the operation; the degree of trauma to the tissues and the number of foreign bodies introduced; the estimated blood and other body fluids lost by sweating and vomiting (in some cases also the fluid intake and urinary output); the method and kind of anæsthetic and the length of anæsthesia; and the general condition of the patient as indicated by appearance, respiration and pulse during the anæsthetic. In the post-operative course of the patient, notes were made on the condition of the wound found at dressings. Also the maximum and minimum temperatures for each day were charted as long as the blood counting was continued. Individual charts were made and curves plotted for the total white and red cell counts and the per cent. of polynuclears.

An ante-operative (A. O.) count was made on the afternoon before the morning operation (in a very few cases just before operation). A second count was made on the afternoon of the day of operation, approximately six hours post operation (P. O.). Another count was made every afternoon following until it returned either to normal or to the initial count. In making averages, those cases which fell to normal before the twelfth day were considered to maintain their final count until that day.

In all of the 51 cases a daily white cell count was made. In 39 a daily differential count was made. In 26 the red cells were counted A. O. and P. O., and on alternate days thereafter.

Although individual charts were made, I have not attempted to draw conclusions from any one case, but I have so grouped the cases according to the common factors, that certain very significant points are brought out.

Findings.—In every single case the white count rose six hours after operation—in 2 cases slightly, in 6 cases to an extreme degree, but in the large majority, quite uniformly doubling itself. Tables II, III and IV give the complete results.

The careful observation of the condition of the wounds at dressings revealed slight infection of the wound in 7 cases and moderate infection in 2 cases—positive cultures being obtained in 6 cases. These 9 cases have been set aside because of the frank presence of a generally accepted leucocyte stimulant. The other 42 cases have been studied both as a whole and divided

TABLE III

Red Cell Counts—26 Cases

Day of count	A. O.	P. O.	2	4	6	8	10	12
Case No.								
14	4,660,000	4,820,000	3,020,000	3,110,000	.....	.....	.....	.....
15	4,770,000	4,930,000	4,760,000	4,040,000	.....	.....	.....	.....
16	5,040,000	4,770,000	4,500,000	.....	.....	.....	.....	.....
17	4,990,000	5,730,000	5,310,000	.....	.....	.....	.....	.....
18	4,990,000	4,600,000	5,080,000	4,780,000	.....	.....	.....	.....
19	4,466,000	4,840,000	4,440,000	4,550,000	.....	.....	.....	.....
20	5,400,000	4,980,000	5,270,000	5,690,000	6,740,000	.....	.....	.....
21	6,300,000	5,290,000	6,050,000	6,440,000	.....	.....	.....	.....
22	5,480,000	6,260,000	4,860,000	4,980,000	4,130,000	4,100,000	.....	.....
23	5,310,000	5,560,000	5,330,000	4,740,000	4,680,000	4,100,000	.....	.....
24	.....	5,240,000	3,720,000	4,210,000	3,950,000	3,880,000	.....	.....
25	3,070,000	3,060,000	4,280,000	3,680,000	3,620,000	.....	.....	.....
26	5,340,000	4,620,000	5,170,000	5,060,000	.....	.....	.....	.....
27	5,190,000	5,990,000	5,270,000	5,110,000	4,140,000	.....	.....	.....
28	3,940,000	4,310,000	4,860,000	.....	.....	.....	.....	.....
29	5,860,000	5,480,000	5,080,000	4,450,000	.....	.....	.....	.....
*30	6,120,000	4,664,000	6,090,000	4,760,000	5,030,000	6,220,000	4,590,000	.....
31	4,070,000	4,850,000	3,650,000	.....	.....	.....	.....	.....
32	4,224,000	3,630,000	3,630,000	4,790,000	.....	.....	.....	.....
33	4,660,000	5,112,000	4,944,000	.....	.....	.....	.....	.....
34	5,240,000	5,470,000	5,380,000	5,760,000	.....	.....	.....	.....
35	5,448,000	4,344,000	4,740,000	4,424,000	4,950,000	4,330,000	4,224,000	.....
36	4,680,000	5,136,000	5,190,000					
37	4,290,000	4,170,000	4,640,000	.....	.....	.....	.....	.....
38	5,280,000	4,950,000	3,520,000	4,176,000	4,370,000	3,056,000	3,770,000	.....
39	5,940,000	6,300,000	5,670,000	4,976,000	.....	.....	.....	.....

* No explanation could be found for the wide variations in this case.

TABLE IV

POLYMORPHONUCLEAR PERCENTAGE—39 CASES

Day of count	A. O.	P. O.	1	2	3	4	5	6	7	8	9	10	11	12
Case No.														
1	67	91	78	75	70	69	....	....	....	....	....	....	....	....
2	36	79	63	63	60	63	55	51	....	....	....	....	....	....
3	70	93	76	81	84.5	76	72	....	....	....	....	....	....	....
4	62	88	69	79	67	67	65	78	66	55	....	....	....	....
5	55	90	83	84	81	83	80	86	85	....	76	86	....	77
6	58	91	86	68	59	....	61	51	....	....	....	....	....	....
7	50	88	70	76.5	69	64	55	....	....	....	....	....	....	....
8	72	84	71	70	....	....	....	....	....	....	....	....	....	....
9	65	86	79	75	76	71	66	59	65.5	72	....	65	....	60
10	70	84	80	69	75	62	56	....	....	....	....	....	....	....
11	85	93	92	86	84	82	87	83.5	80.5	....	....	....	....	....
12	72	89	77	75	69	62	....	....	....	....	....	....	....	....
13	50	88	73	76	63	58	83	54	55	....	....	....	....	....
14	70	85.5	80.5	79	76.5	74.5	76	86	81	79	86	....	73	....
15	67	85.5	78.5	73	72	76	68	....	....	....	....	....	....	....
16	47	90	74	52	45.5	....	....	....	....	....	....	....	....	....
17	67	85.5	67	79	70	....	....	....	....	....	....	....	....	....
18	73	89	70	72.5	66	67.5	....	....	....	....	....	....	....	....
19	85.5	91	90	83.5	76.5	69.5	....	....	....	....	....	....	....	....
20	71	85	80	82.5	85.5	83.5	70	73.5	79.5	....	....	....	....	....
21	66.5	88	70.5	70.5	62.5	58	....	....	....	....	....	....	....	....
22	61	94.5	86.5	83.5	60	75.5	72	65.5	67	76	62	....	....	....
23	72	89.5	70.5	65	76	59	70.5	75.5	63	....	57	....	....	....
24	78	92	83.5	76	78	75	68	69	71.5	....	60	....	48	....
25	68.5	91	76	87	79.5	78.5	86.5	....	....	....	....	....	....	....
26	64	83.5	82	72.5	75.5	64	....	....	....	....	....	....	....	....
27	62	95.5	83.5	82	74	75	78	69.5	64.5	....	....	....	....	....
28	59	59	60	46	....	....	....	....	....	....	....	....	....	....
29	57	88.5	77.5	73	66	63	....	....	....	....	....	....	....	....
30	79	82	80.5	77.5	76.5	69.5	61.5	69	62	67	61.5	56	....	....
31	69	93	74.5	67	....	....	....	....	....	....	....	....	....	....
32	56	86	75	72.5	67.5	74	....	....	....	....	....	....	....	....
33	64	88	73	63	65	....	....	....	....	....	....	....	....	....
34	47.5	90	84	80	60.5	57.5	61.5	....	....	....	....	....	....	....
35	62	94.5	79.5	72	74	65.5	71	71	63.5	63.5	64	65	....	....
36	59.5	85.5	79	70.5	71.5	....	....	....	....	....	....	....	....	....
37	70.5	79.5	66.5	60	....	....	....	....	....	....	....	....	....	....
38	69	92.5	81.5	83	80.5	75	77	71.5	76.5	66	79	68.5	....	....
39	67.5	89	79	81.5	73	67.5	69.5	....	....	....	....	....	....	....

into groups according to various classifications, in the attempt to bring out the factors in the leucocytosis.

These classifications consider (*a*) the sex and type of individual, (*b*) the kind and duration of the anæsthetic, (*c*) the character of the operation with respect to contamination, (*d*) the degree of trauma to the tissues, (*e*) the number of foreign bodies introduced, and (*f*) the blood loss. The factor of concentration of the blood, which Da Costa and Kalteyer emphasize, was considered, but was found to have in itself so many sub-factors, that it was impossible to make any satisfactory classification upon that basis. In it there had to be considered—daily fluid intake and output; ante-operative purging; sweating, temperature and humidity of the operating room, and general weather conditions affecting sweating; vomiting during and after

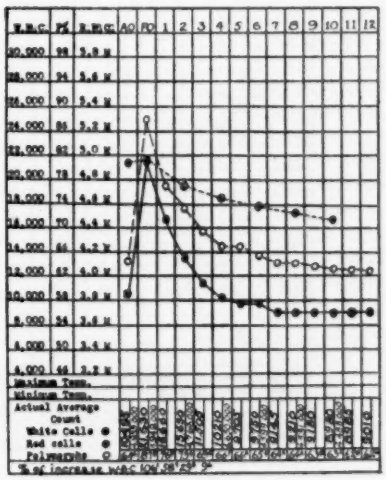

FIG. 1.—All of the 42 non-infected cases. White cell count in 42. Differential count in 33. Red cell count in 22.

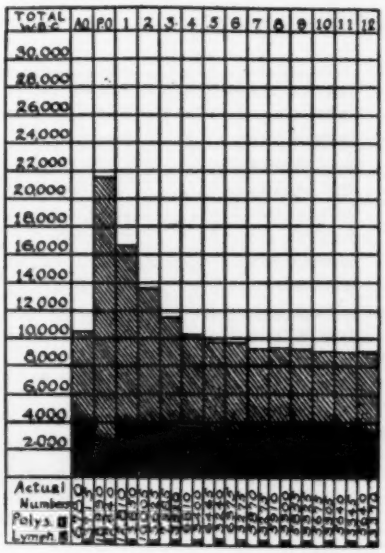

FIG. 2.—Showing that the leucocytosis is essentially a polynucleosis.

operation; post-operative colon irrigations, enemata and rectal administration of fluids. There were not two cases alike in all of these phases. Furthermore, the trivial rise in red cells (see Fig. 1) and the actual fall in lymphocytes (see Fig. 2) indicate that mere concentration of the blood is a minimal factor.

The composite curves in the 42 non-infected cases taken as a whole are shown in Fig. 1. The letters and numbers at the top indicate the days on which the counts were made. At the left are the figures representing the various levels of the count in white cells, red cells, and per cent. of polynuclears. At the bottom are the actual average figures and the per cent. of white cell increase over the initial count. The dots and solid lines represent the curve of the white cells, the circles and dash lines, the polynuclears, the wheels and dotted lines, the red cells.

In these cases it will be seen that the average A. O. blood count was as follows: White blood-cells, 10,495, polymorphonuclears, 64.6 per cent., red blood-cells, 4,939,000. Six hours P. O. it became: white blood-cells, 21,630, polymorphonuclears, 87.8 per cent., red blood-cells, 4,948,000. Thus, in six hours, the total white cells increased 106.1 per cent., the polymorphonuclears 36 per cent., and the red cells less than 0.2 per cent. On subsequent counts there was a rapid falling off of total white cells and polynuclears—the white cells falling below the initial count on the fourth day P. O. The polys fell more gradually but reached the initial count on the seventh day. The red cells fell gradually and progressively throughout the ten days P. O. with an average loss in that time of 451,000 cells per c.mm. An application of Sondern's [1] resistance line to this count would show a change in the direction of the line from a sharp decline to a slight rise on the first two counts with a subsequent return to the original direction.

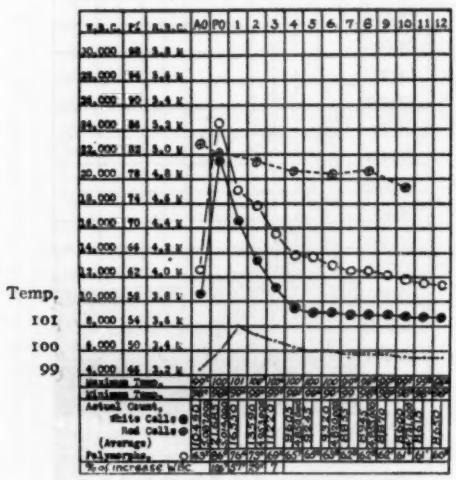

FIG. 3.—Clean cases. White cell count in 28. Differential count in 23. Red cell count in 14.

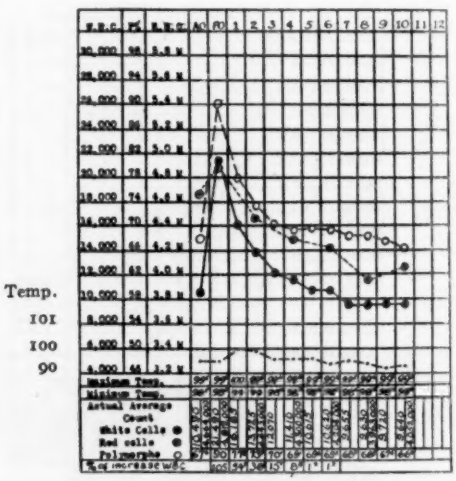

FIG. 4.—Borderline cases. White cell count in 14. Differential count in 10. Red cell count in 8.

Fig. 2 shows very plainly that the response is due entirely to the polymorphonuclear leucocytes, for the total number of these cells rapidly increases while the actual number of lymphocytes remains practically constant.

In order to determine the influence of infection and contamination, the 42 non-infected cases have been divided into clean cases, of which there were 28, and borderline cases, of which there were 14. Clean cases are considered to be those in which the operation from beginning to end is kept sterile, with no contamination of the operative field. Borderline cases are those in which a certain amount of contamination of the field is expected, such as occurs, for instance, in operations on the female genital tract or on the gastro-intestinal tract and its appendages (with the exception of the vermiform appendix operation which is clean). The composite curves for this division are shown in Figs. 3 and 4. With these curves, the reader

should compare Fig. 5 which gives the results in the 9 infected cases. On these three charts the composite temperature curves are also plotted. The uniformity with which the white count rises in these three groups is most striking. In the clean group the six-hour P. O. rise is 106.7 per cent. over the initial count. In the borderline cases it is 105 per cent. In the infected cases it is 105 per cent. This seems to indicate that infection or contamination has nothing whatever to do with the initial rise. The influence is seen, however, in the later days. In the clean cases the count returns to normal on the fourth day; in the borderline cases on the seventh day; in the infected cases not until the twelfth day. Infection, therefore, although it is not responsible for the rise, does delay the fall—the effect beginning on the second or third day P. O.

The temperature curves on these charts show that the rise in tempera-

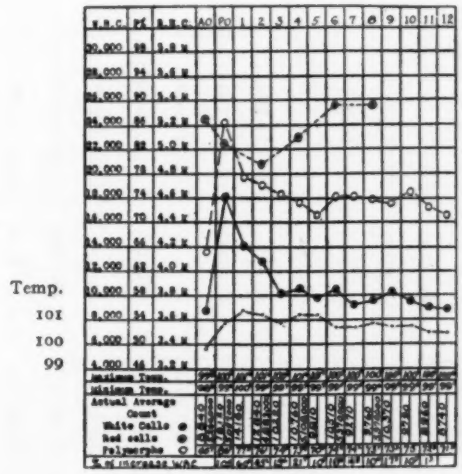

FIG. 5.—Infected cases. White cell count in 9. Differential count in 6. Red cell count in 4.

ture P. O. does not correspond, in time, to the rise in white cells, but is a later phenomenon of the post-operative reaction.

An interesting observation with respect to the infected cases is that in three of them Staphylococcus albus was recovered, and in all three the count fell to normal with the same rapidity that it did in the clean cases. With one exception, where other organisms were present, and in those cases in which positive cultures were not obtained (possibly anaërobic organisms were present) the count remained high.

Table V shows the cases grouped according to sex. Here it is seen that in 15 males the white cells increased 100.4 per cent. over the initial count, while in 27 females the rise was 108.7 per cent. Here there is a difference of only 8.3 per cent. The count in the male cases falls to normal one day before the count in the female cases. Apparently the factor of sex is unimportant.

TABLE V

CLASSIFICATION ACCORDING TO SEX

	Male, 15				Female, 27			
	White blood-cells	Per cent. of increase	Polymorpho-nuclears, per cent.	Red blood-cells	White blood-cells	Per cent. of increase	Polymorpho-nuclears, per cent.	Red blood-cells
A. O.	10,690	.....	64.1	5,241,000	10,380	.....	64.9	4,753,000
P. O.	21,475	100.4	86.9	4,983,000	21,600	108.7	88.4	4,932,000
1	16,135	50.9	75.6	.....	16,690	60.8	77.7	.....
2	13,865	27.8	75.8	5,059,000	13,640	31.4	72.1	4,604,000
3	11,265	5.4	70.9	.....	11,700	12.7	68.5	.....
4	9,220	.....	67.8	4,835,000	10,750	3.6	65.9	4,551,000
5	9,080	.....	67.2	.....	10,090	.....	64.9	.....
6	9,160	.....	66.5	4,865,000	10,090	.....	63.5	4,445,000
7	8,795	.....	65.7	.....	9,340	.....	63.5	.....
8	8,935	.....	66.3	5,016,000	9,370	.....	62.5	4,280,000
9	8,795	.....	65.9	.....	9,410	.....	62.1	.....
10	8,385	.....	65	4,812,000	9,300	.....	61.5	4,323,000
11	8,385	.....	65	.....	.....	.....	.....	.....
12	8,390	.....	64.6	.....	.....	.....	....	.....

TABLE VI

CLASSIFICATION ACCORDING TO TYPE OF INDIVIDUAL

	Average 20				Obese 14				Neurotic 5		Asthenic 3	
	White blood-cells	Per cent. of increase	Polymorphonuclears, per cent.	Red blood-cells	White blood-cells	Per cent. of increase	Polymorphonuclears, per cent.	Red blood-cells	White blood-cells	Per cent. of increase	White blood-cells	Per cent. of increase
A. O.	10,635	.....	63.9	5,043,000	10,500	.....	63.9	5,099,000	10,900	....	12,065	....
P. O.	22,725	113.7	90	5,235,000	21,505	104,8	86,2	4,708,000	18,380	68.7	20,200	67.4
1	16,165	52	77.7	.....	15,570	48.3	74.8	.....	19,620	80	16,915	40.2
2	13,615	28	73.6	4,735,000	13,200	25.7	73	4,855,000	12,580	15.4	17,635	46.2
3	11,640	9.4	69.7	.....	11,010	4.9	69	.....	12,200	12	11,750	....
4	10,300	.....	66.9	4,560,000	9,185	.....	65.5	4,826,000	10,250	....	12,665	5
5	9,575	.....	67.1	.....	9,345	.....	66.1	.....	9,980	....	11,865	....
6	9,360	.....	63.9	4,496,000	9,745	.....	67.5	4,889,000	10,130	....	11,500	....
7	9,090	.....	63.8	.....	8,865	.....	65.2	.....	9,180	....	10,450	....
8	9,160	.....	64.2	4,434,000	8,970	.....	63 .7	4,801,000	9,140	....	.....	....
9	9,215	.....	63.5	.....	8,935	.....	63.8	.....	8,760	....	.....	....
10	9,025	.....	63.2	4,424,000	8,770	.....	62.4	4,686,000	8,760	....	.....	....
11	9,035	.....	62.5	.....	.....	.....	....	.....	.....	....	.....	....
12	9,090	.....	62.2	.....	.....	.....	....	.....	.....	....	.....	....

The classification according to the type of the individual divides the cases roughly into four groups: Average (20), obese (14), neurotic (5), and asthenic (3). These groups are shown in Table VI. We see by this group that the so-called average cases rise to 113.7 per cent. over the initial count. The obese cases rise to 104.8 per cent. The neurotic cases to 68.7 per cent. on the second count and 80 per cent. on the third. The three asthenic cases increased only 67.4 per cent. In the last two groups there are, of course, too few cases from which to draw definite conclusions, but apparently the factor of type of individual is important.

Figs. 6 and 7 show the curves in 24 ether cases and 18 gas and oxygen cases, respectively. The difference here is striking. In the ether cases the P. O. rise is 121.9 per cent. of the initial count with a return to normal on the fifth day. In the gas and oxygen cases the rise is only 85.1 per cent., and the return is on the fourth day. There is a difference here of 36.8

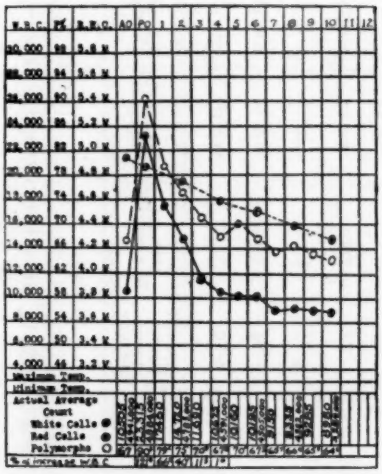

FIG. 6.—Ether cases. White cell count in 24. Differential count in 16. Red cell count in 11.

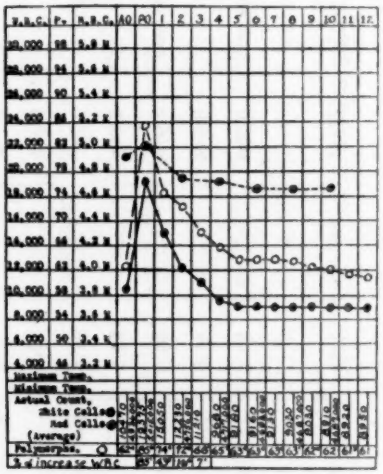

FIG 7.—Gas and oxygen cases. White cell count in 18. Differential count in 17. Red cell count in 11.

per cent. The red cell curves on these two charts show a much greater post-operative fall in the ether cases than in the gas and oxygen cases. In this series, there was no special selection of cases for either gas-oxygen, or ether. Long and short, severe and easy cases were performed under both ether and gas-oxygen. In most of the gas-oxygen cases a small amount of ether was used, from ℥j to ℥ij.

The average duration of anæsthetic administration was found to be one hour and ten minutes. The cases were accordingly divided at this point into long-anæsthetic cases and short-anæsthetic cases. Table VII contrasts 19 long-anæsthetic cases where the increase is 114.4 per cent. and the return on the fourth day, with 23 short-anæsthetic cases where the count increased 97.9 per cent. and returned on the fourth day. The difference here is 16.5 per cent.—not striking but nevertheless real. It should be remembered that a much larger amount of anæsthetic is required

TABLE VII

CLASSIFICATION ACCORDING TO DURATION OF ANÆSTHESIA

	Short, 23				Long, 19			
	White blood-cells	Per cent. of increase	Polymorpho-nuclears, per cent.	Red blood-cells	White blood-cells	Per cent. of increase	Polymorpho-nuclears, per cent.	Red blood-cells
A. O.	9,885	....	61.7	4,782,000	11,225	.....	68.5	5,253,000
P. O.	19,565	97.9	81.5	4,871,000	24,080	114.5	89.2	5,077,000
1	14,610	47.8	74.8	.....	18.630	65.9	79.7	.....
2	12,085	22.3	71.4	4,796,000	15,495	38	76.7	4,720,000
3	10,865	9.9	67.7	.....	12,280	9.4	71.1	.....
4	9,535	....	64.5	4,657,000	11,025	.....	69.1	4,649,000
5	9,045	....	65.4	.....	10,505	.....	68.4	.....
6	9,000	....	64.8	4,579,000	10,665	.....	66.4	4,635,000
7	8,565	....	63.2	.....	9,840	.....	66.3	.....
8	8,465	....	62.6	4,538,000	10,105	.....	66.9	4,528,000
9	8,490	....	62.3	.....	10,015	.....	65.7	.....
10	8,490	....	62.3	4,538,000	9,570	.....	64.2	4,401,000
11	.....	....	....	.....	9,590	.....	63.3	.....
12	.....	....	....	.....	9,640	.....	63	.....

for the induction than for the last stages of anæsthesia, and perhaps the amount is a much more important factor than the mere duration, but this is difficult to measure, especially in the gas and oxygen cases. The difference in the red cell curves is more striking than the changes in the white cells—the red count falling much more rapidly in the cases with long anæsthesia.

The results in the classification according to the degree of trauma to the tissues are shown in Figs. 8 and 9. Trauma was considered to consist of cutting, tearing, and handling the tissues. Twenty-five cases were subjected to marked trauma and in these the rise was 114 per cent. over the initial count. Seventeen cases had only slight trauma and the rise was only 90.7 per cent. The difference between these is 23.7 per cent. In both, the

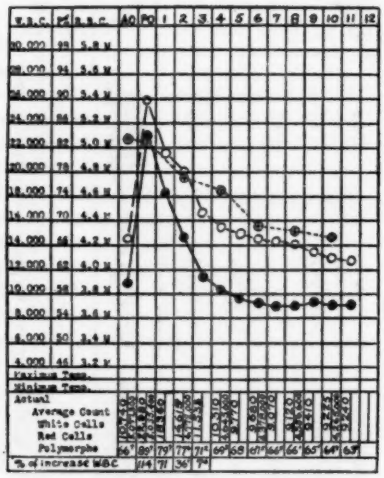

FIG. 8.—Cases receiving marked trauma. White cell count in 25. Differential count in 19. Red cell count in 10.

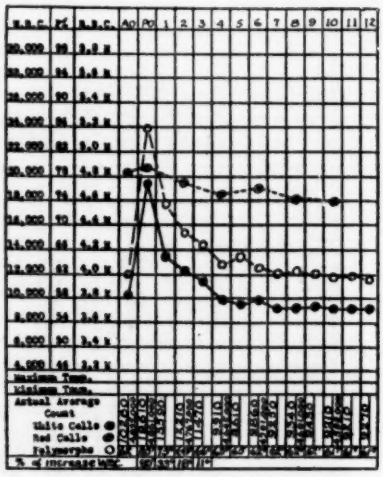

FIG. 9.—Cases undergoing slight trauma. White cell count in 17. Differential count in 15. Red cell count in 12.

count returned to normal on the fourth day. Here also the progressive anæmia is more pronounced in the cases with increased trauma than in those with slight trauma.

The cases were also divided into two groups according to the number of foreign bodies left in the tissues. At the time of operation every stitch and ligature was counted. In this summary no differentiation is made between the various materials used. Each stitch and ligature was counted as 1 and in the four cases in which drainage for bleeding was necessary, each drain was counted arbitrarily as 5. The average was 40. Fig. 10 shows 19 cases which had more than 40 foreign bodies left in. The rise here is 119 per cent. over the initial count. Fig. 11 shows the composite curves in 23 cases in which less than 40 foreign bodies were introduced. The rise in these cases is 96.3 per cent., and the difference between the two groups is 22.7 per cent. The stimulating effect of suture material, however, does not seem to be of long duration, since those cases with many foreign bodies

return to normal before those with few. The fall in red cells is practically the same in these two groups.

The last grouping is according to the blood loss. In only one case was there any large amount of blood lost (9 ounces). The smallest amount was 1 drachm. The average was found to be 2 ounces. The 22 cases in which more than that amount was lost are shown in Fig. 12. Here the initial rise is seen to be 119.7 per cent., falling on the fifth day. In 20 cases losing less than 2 ounces (Fig. 13) the rise is 90.3 per cent., falling on the fourth day. The difference is 29.4 per cent.

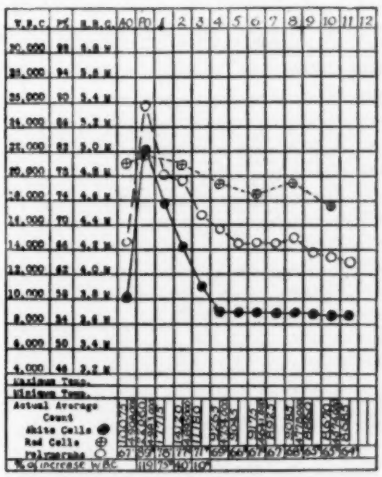

FIG. 10.—Cases retaining more than forty foreign bodies. White cell count in 19. Differential count in 12. Red cell count in 8.

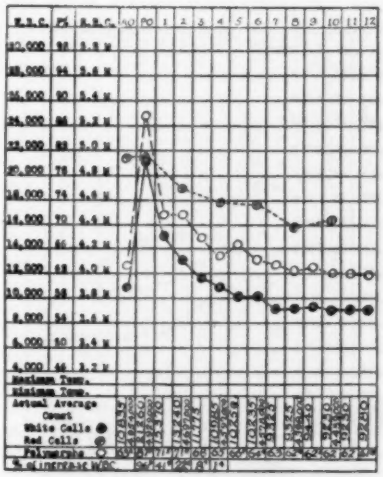

FIG. 11.—Cases retaining less than forty foreign bodies. White cell count in 23. Differential count in 21. Red cell count in 14.

DISCUSSION

From the first five charts certain facts are available. From the others only inferences may be drawn. It is a fairly generally accepted theory that the outpouring of leucocytes is a reaction to injury. If that theory be true, there are two variable factors—first, the kind or degree of injury; second, the resistance or vigor of the reacting individual. Up to a certain point the greater the injury and the greater the resistance of the individual, the greater will be the reaction. The foregoing charts indicate that an operation performed under an anæsthetic is sufficient injury to cause a marked increase in the white cell count. Severe trauma to the tissues and organs, introduction of a large number of foreign bodies, long anæsthesias, especially with ether, and much loss of blood, cause the greatest reactions and may be considered to be the severest injuries. All of these factors are more or less under the control of the operating surgeon. The resistance of the patient is not so easily controlled, but it must be considered as an active factor in the variation in the count. If the above observations be true, it is obvious that any case having all of the above leucocyte stimulating factors ought to have a very high count. On the other hand, any case

having none of these factors ought to have a very low count. There are just three cases in this series which represent these extremes and their charts bear out the points just made. The curves of two of these are shown in Figs. 14 and 15. The first case is an average female with long ether anæsthesia, increased trauma, many stitches, and much loss of blood. The second case is an obese male with a short gas and oxygen anæsthesia, slight trauma, few stitches, and small loss of blood.

The third case, in which only the white cells were counted, shows this even more strikingly—L. A., an average female—ether anæsthesia for one

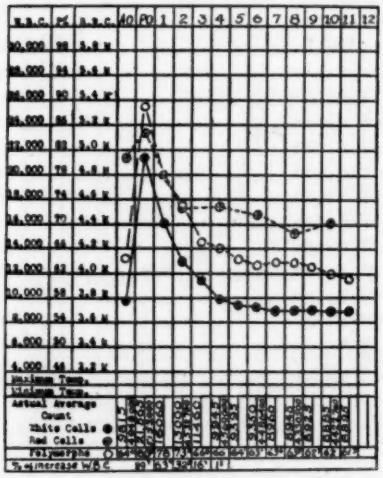

FIG. 12.—Cases losing more than two ounces of blood. White cell count in 22. Differential count in 15. Red cell count in 11.

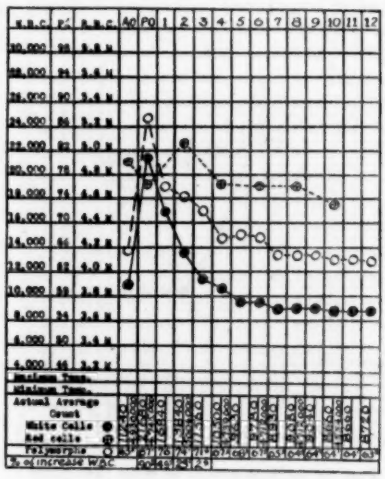

FIG. 13.—Cases losing less than two ounces of blood. White cell count in 20. Differential count in 18. Red cell count in 11.

hour and twenty-eight minutes, marked trauma, 62 foreign bodies introduced, blood loss, 4 ounces. The count follows:

	White blood-cells	Per cent. of increase
A.O.	10,250	.....
P.O.	25,250	146.3
1	17,650	72.2
2	15,700	53.1
3	12,450	21.5
4	12,300	20
5	10,350	1
6	10,550	1

The absolute control of every factor mentioned above is impossible either with human beings or with experimental animals. Some attempt has been made to control certain of them, however.

1. The variation between the sexes with respect to the blood reaction to injury has never been carefully observed. The slight difference in the reaction given by the two sexes in this series may be accidental, or it may be due

to the fact that the average female ward patient is generally in relatively better physical condition than the average male ward patient.

2. It has frequently been found in acute infective conditions that a weak individual gives a weak leucocytic response to the infection. Likewise, in non-infective conditions, apparently, the "average" patient, who is obviously more healthy than the obese, the neurotic, or the asthenic, is more capable of giving a strong reaction. An interesting observation was made in one of my cases—a very neurotic individual. The evening before the day scheduled for operation, she became almost panic stricken with fear and in the morning refused operation. The count went up from 12,200 to 17,400 without operation. This was considered at the time to be a neurotic manifestation, but Table V seems to show that nervousness is not a leucocytic

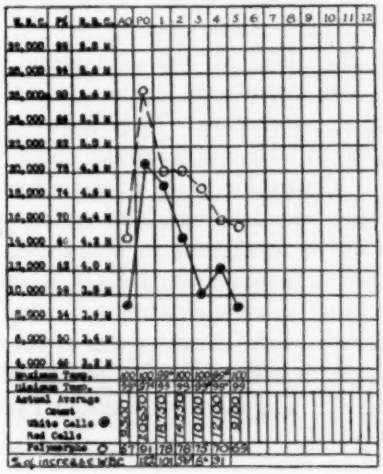

FIG. 14.—Case showing all of the leucocyte stimulating factors. Average female; ether, one hour twenty minutes; marked trauma; foreign bodies, forty-eight; blood loss, three ounces.

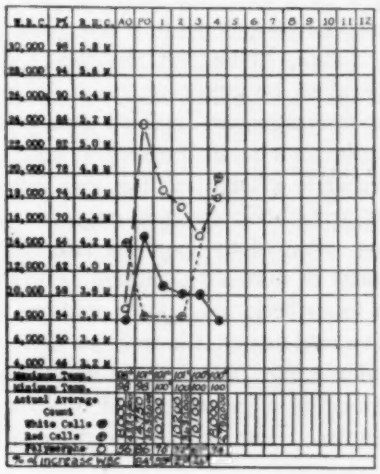

FIG. 15.—Case showing a minimum number of leucocyte stimulating factors. Obese male; gas and oxygen, one hour nine minutes; slight trauma; foreign bodies, twenty-nine; blood loss, three drachms.

stimulant. One of the other neurotic cases was one of the two cases to have only a slight post-operative rise (Case 28).

3. Mann [8] has shown that where anæsthesia in dogs is kept up continuously for three or four hours, there is a doubling of the count at the end of four hours. Krumbaar [9] likewise showed that anæsthesia in dogs causes a leucocytosis. Chadbourne [5] found this increase to be most marked in the early stages of anæsthesia. I counted one case in the hospital which seems to bear out this observation. Unfortunately, no ante-operative count was made. The first count was made three minutes after anæsthesia had started. Thereafter a count was made every fifteen minutes throughout a two-hour operation. The case was a very difficult double hernia with balls of omentum down in the scrotum. (Incidentally I may say that large herniæ frequently give counts between 10,000 and 15,000 A. O.) This count follows:

3 minutes, white blood cells	18,450	Polymorphonuclears, 74 per cent.
18 minutes, white blood cells	23,500	Polymorphonuclears, 64 per cent.
33 minutes, white blood cells	27,950	Polymorphonuclears, 61 per cent.
48 minutes, white blood cells	27,750	Polymorphonuclears, 62 per cent.
63 minutes, white blood cells	29,450	Polymorphonuclears, 69½ per cent.
78 minutes, white blood cells	26,750	Polymorphonuclears, 68 per cent.
93 minutes, white blood cells.....	29,450	Polymorphonuclears, 62½ per cent.
108 minutes, white blood cells	29,750	Polymorphonuclears, ... per cent.
After 6 hours, white blood cells	32,800	Polymorphonuclears, 90½ per cent.
First day P.O., white blood cells	22,350	Polymorphonuclears, 86½ per cent.
Second day P.O., white blood cells	16,550	Polymorphonuclears, 84½ per cent.
Third day P.O., white blood cells	13,550	Polymorphonuclears, 72 per cent.
Fourth day P.O., white blood cells	9,700	Polymorphonuclears, 73 per cent.
Fifth day P.O., white blood cells	9,700	Polymorphonuclears, 69 per cent.

I have no explanation to offer for the fact that in this case the polymorphonuclears made a later rise than the total white cells.

Cabot, Blake and Hubbard [7] studied the effect of both anæsthetic and operation by counting the blood just before anæsthesia, again just before the operation, and a third time just after the operation. They found practically no rise in the second count, but in half of the cases the count immediately after operation was increased. Thus their study of the effect of the anæsthetic covered only ten to twenty minutes time, and no account was taken of the possible late effect of either anæsthetic or operation. It would be difficult in human beings to obtain a large series of cases in which an anæsthetic was given without some kind of an operation following it. I counted one case in which a closed reduction of the shoulder was attempted under ether. Here there was some trauma to the tissues but no introduction of foreign bodies and no loss of blood. The anæsthetic lasted twenty minutes. The leucocytes ran as follows:

Just before anæsthesia, white blood cells.....	6,300
Just after operation, white blood cells.....	6,300
Six hours P.O., white blood cells.....	13,200
First day P.O., white blood cells	11,800
Second day P.O., white blood cells	8,300
Third day P.O., white blood cells.....	10,400
Fourth day P.O., white blood cells.....	8,300

It is somewhat easier to control the factor of anæsthesia by exclusion, *i.e.*, by counting a series of cases performed under local anæsthesia. This I did in four cases with the following results:

1. A.O., white blood cells.....	7,600	Polymorphonuclears, 40 per cent.
P.O. (8 hrs.), white blood cells..	14,450	Polymorphonuclears, 79 per cent.
2. A.O., white blood cells	8,400	Polymorphonuclears, 63 per cent.
P.O. (8 hrs.), white blood cells..	14,800	Polymorphonuclears, 73 per cent.
3. A.O., white blood cells	8,000	Polymorphonuclears, 54 per cent.
P.O. (14 hrs.), white blood cells.	12,350	Polymorphonuclears, 74 per cent.
4. A.O., white blood cells	9,700	Polymorphonuclears, 61 per cent.
P.O. (6 hrs.), white blood cells..	12,000	Polymorphonuclears, 81 per cent.

Cases 1 and 2 were herniæ. Cases 3 and 4 were varicoceles. Of course, these cases are relatively simple and are in no sense representative operations with respect to trauma, foreign body introduction or blood loss, nevertheless, the counts show that the operation itself is a definite leucocytic stimulant, even if it is not the only one.

4. The factors of trauma and foreign body introduction cannot be controlled in human beings separately, and ordinarily they are complicated by the factors of anæsthesia and blood loss. Furthermore it is not practical to attempt to show the importance of one or another form of suture material used in operations on human beings, since, in practically every case, all forms are introduced. Lampé [4] showed in a few cases in dogs that iodized catgut produced a higher leucocytosis than silk, when used in operations.

5. The factor of blood loss has been studied by Krumbaar,[9] who has recently shown that the removal of 75 to 100 c.c. of blood produces a leucocytosis in dogs, even when no anæsthetic has been given. If this be true in human beings, for relatively small amounts, as Figs. 12 and 13 seem to indicate, the loss of large amounts of blood does not seem to have a corresponding effect. I made counts on three donors for transfusion. Five hundred c.c. of blood was taken from each one without anæsthetic. Although no definite conclusions can be drawn from only three cases, I introduce their counts here, considering them to be interesting observations in this connection.

	First case	Second case	Third cas
Just before phlebotomy, white blood cells	6,200	8,200	10,800
Just after phlebotomy, white blood cells	8,900	7,500	9,000
About 6 hours after phlebotomy, white blood cells	7,900	6,400	7,700
About 30 hours after phlebotomy, white blood cells	.....	.....	8,600

It is conceivable that where small losses of blood, up to a certain point, would stimulate leucocytosis, large amounts are too great to be more than just compensated for by the hæmatopoietic activity of the body.

CONCLUSIONS

1. In surgical cases undergoing operation without infection, the white cells increase in number, and about six hours after operation have more than doubled.

2. The response is due almost entirely to the outpouring of polymorphonuclear cells.

3. There is a trivial rise in red cells after operation, but in the subsequent ten days this is followed by a progressive anæmia with an average loss of about one-half million cells per c.mm.

4. The white cell count may be expected to fall rapidly in clean cases and reach normal on the fourth day. In infected or contaminated cases it will fall much more slowly.

5. Infection and contamination have nothing to do with the initial rise, but on the second or third day after operation they will tend to keep the count high.

6. Other things being equal, the count will be higher in those cases in which there are severe trauma to the tissues, many sutures and ligatures used, considerable loss of blood and long anæsthesia, especially with ether.

7. Normal individuals will produce a higher leucocytosis than abnormal types.

I wish to express my sincere thanks to Dr. Guy A. Caldwell for helping me plan this study and for counting foreign bodies introduced at operation.

REFERENCES

[1] Sondern, F. E.: Medical Record, 1905, lxvii, 452.
[2] Gibson, C. L.: ANNALS OF SURGERY, 1906, xliii, 485.
[3] Wilson, L. B.: Journ. Minn. Med. Assn., 1908, xxviii, 259 (abstract).
[4] Lampé, E., Jr.: Beitr. z. Klin. Chir., 1911, lxxiv, 231.
[5] Chadbourne, T. L.: Phila. Med. Journ., 1899, iii, 390.
[6] Da Costa, J. C., and Kalteyer, F. J.: ANNALS OF SURGERY, 1901, xxxiv, 329.
[7] Cabot, R. C., Blake, J. B., and Hubbard, J. C.: ANNALS OF SURGERY, 1901, xxxiv, 361.
[8] Mann, F. C.: Journ. Amer. Med. Assn., 1916, lxvii, 172.
[9] Krumbaar, E. B.: ANNALS OF SURGERY, 1917, lxvi, 133.

ELECTRIC BURN CAUSING NECROSIS OF THE SKULL

By Dean Lewis, M.D.
of Chicago, Ill.

About 500 persons are killed each year in the United States by lightning. It is difficult to estimate the number of shocks or burns sustained by those working in electrical plants or in wiring, for the accidents are not reported when recovery occurs. The number of fatal accidents is undoubtedly small, but is on the increase, as is indicated by various statistics dealing with this subject. The statistics published by Langer show that there were 58 fatal electrical accidents in Germany in 1908, 139 in 1910, and 183 in 1912.

The case about to be reported presents some interesting features. The patient recovered from a very severe shock, having come in contact with a live wire carrying an alternating current of 13,200 volts with an amperage of 150. He sustained an injury to the skull which corresponds to a certain definite type of which 13 have been reported. Some eight weeks after the accident a double cataract developed rather rapidly.

Mr. C. G., age 27, referred by Dr. T. B. Smith, of Clifton, Arizona, while working at his trade on a corrugated tin roof came in contact by his head with a live wire carrying an alternating current of 13,200 volts. He was immediately knocked unconscious. It is not known how long he remained unconscious, but it is estimated that it was probably fifteen minutes after he was shocked before his friends reached him. At this time he was just beginning to move. The patient became irrational and violent when he came to, and it required three or four men to restrain him. Six hours after the accident he became rational. He suffered no particular pain at this time, but was unable to find a comfortable position. The face was so swollen that the eyes could not be opened. No special pain was noted in the areas about the head and face which had been most severely burned.

The physician who examined him shortly after the shock stated that the scalp over the junction of sagittal and coronal suture had been burned away, leaving exposed a part of the parietal and frontal bones measuring 4 in. in diameter. A burn of the forehead on the right side and one over the right parotid gland were noted. This latter burn had extended deep enough to destroy the fibres of the facial nerve passing through the gland. The gland substance was also partially destroyed, as the patient had a salivary fistula. Stenson's duct was apparently intact. The skin surrounding the areas which were burned was charred, but gradually the charred skin sloughed away. Sloughing was complete in about three weeks.

The feet were severely damaged by the electric shock. Above the right ankle, anteriorly, the skin was badly charred, as is shown in Fig. 4, and the skin over the dorsum of the right foot was torn longitudinally and burned. All the toes with the exception of the little one

were so badly torn and burned that they either dropped off or were removed.

A circular burn occurred upon the left leg above the ankle which corresponds in position to the level at which the shoe top came in contact with the skin. This burn extended down to the bone, destroying all the tendons above the ankle and dividing posteriorly the tendo Achillis. The electric current had apparently passed down the upper and outer side of the foot, lacerating and burning the skin on the dorsum of the foot and destroying the little toe.

Sloughing of the charred skin occurred much more quickly in this case than in cases resembling it which have been reported. Separation of the skin was completed in three weeks. Granulation tissue then developed rapidly and normally.

Almost eight weeks after the accident slight blurring of the vision of the left eye was noticed. The blurring lasted for two days and then the eye became hypersensitive to light for one and one-half days. The blurring of vision became progressively worse after this until vision was completely lost. The same change then occurred in the right eye, beginning February 6, 1917. When the patient entered the hospital February 21, 1917, he had a well developed bilateral cataract.

When examined upon admission to the hospital February 21, 1917, a large area of exposed necrotic bone involving both the parietal and frontal bones was found. The soft tissues surrounding the necrotic bone were in good condition. The necrotic bone was somewhat loose, but at this time was not loose enough to indicate an attempt at removal. The sequestrum shown in Fig. 1 finally became so loose that on April 12, 1917, it could be easily removed with tissue forceps. The sesquestrum contains a part of the sagittal and coronal sutures at the point of meeting and the parts of the parietal and frontal bone adjoining these. It includes both plates. The dura which was exposed when the sequestrum was removed was covered with healthy granulation tissue. This granulating surface was grafted on the day following removal of the sequestrum with Thiersch grafts.

The granulating surface over the parotid gland was moist, a small salivary fistula having formed as a result of the burn extending into the gland substance. The fibres of the facial nerve were apparently destroyed by this burn for there is a complete facial palsy on the right side. This surface was also covered with Thiersch grafts. The discharge of saliva gradually ceased. The granulating surface has gradually healed, most of the skin grafts having taken.

At the time these granulating surfaces were grafted, a pedunculated graft was turned down from the side of the left leg to cover the granulating surface above the ankle in order to prevent the contraction of a circular scar, as an œdema of the foot was fast developing, and there was marked interference with the circulation of the foot. A considerable amount of fat was taken with this graft, as subsequently an attempt may be made to repair the destroyed tendons by the transplantation of fascial strips.

There are no changes in the respiratory, digestive, vascular or

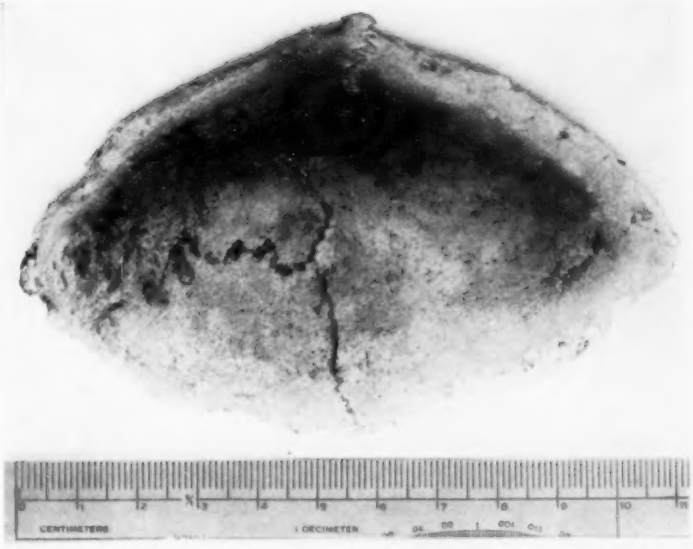

FIG. 1.—Sequestrum of parts of the parietal and frontal bones, including both tables, which was removed eighteen weeks after the accident. The sequestrum was so loose by this time that it could be removed with tissue forceps. The underlying dura was covered with healthy granulation tissue. The superior longitudinal sinus was intact.

FIG. 2.—Size of defect following removal of sequestrum. Defect has been covered with Thiersch grafts

FIG. 3.—Shows burns over the right parotid gland and facial palsy. The peculiar expression of the eye is due to the cataract.

FIG. 4.—Indicates the extent of the injury to the feet. The flap covering the granulating surface above the left ankle anteriorly has been turned down from the side of the leg. This area has not yet been covered with grafts.

genito-urinary system. Muscular movements are made normally without any incoördination. There are no changes in the nervous system which are marked. The patient complains of some numbness of the fingers, but there are no areas of anæsthesia, and also of some pain in the back.

There was quite a marked loss in weight after the accident. During the last few weeks there has been a gradual increase in weight and strength.

A peculiar reaction followed needling of the cataract which was performed under local anæsthesia. The temperature became subnormal and the patient suffered for a few hours from a condition resembling quite severe shock.

There are recorded in the literature 13 cases of skull injuries caused by electric shocks which present much the same picture as that just described. The head has come in contact with a live wire carrying a high voltage, and has been severely burned. The associated injuries have varied, depending upon which part of the body has been in contact with a conductor. In one case there occurred a gangrene of the arm which necessitated amputation. Five of these cases died. The case which I have described came in contact with a wire with a much greater voltage than any that has yet been reported.

In two of the cases the bone has been fused or destroyed as a direct result of the burn. In a fatal case described by Gerlach, a hole having a diameter of a dollar was burned down to the dura. In another fatal case described by Jellinek, the bones of the head contacted with the wire were fused, so that several small hollow bullet-like masses of calcium acid phosphate were formed.

In some instances the sequestrum separated very slowly. In this case separation was complete in a little over three months.

In none of the cases of the type under discussion, which have been reported, have eye changes been noted. Beginning eight weeks after the accident, a bilateral cataract developed. These have been operated upon by Dr. E. V. L. Brown. The cataract in the right eye has been removed, and apparently the retina has not been injured. Hemorrhages into the conjunctiva, clouding of the cornea, iritis, the development of cataracts, separation of the retina, optic atrophy, and paralysis of the eye muscles have been observed after lightning strokes, but as far as I know none of the cases of this type of electrical shock, except the one just described, have had any marked eye changes.

FIG. 3.—Shows burns over the right parotid gland and facial palsy. The peculiar expression of the eye is due to the cataract.

FIG. 4.—Indicates the extent of the injury to the feet. The flap covering the granulating surface above the left ankle anteriorly has been turned down from the side of the leg. This area has not yet been covered with grafts.

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DEEP PALMAR HAND INFECTIONS

A CLINICAL STUDY OF THE DIAGNOSIS AND TREATMENT OF THESE CONDITIONS

By Howard L. Beye, M.D.
of Iowa City, Iowa
(From the Department of Surgery, College of Medicine, University of Iowa)

The most important part of the treatment of any infection of the palm of the hand is a correct diagnosis of the localization of the infection. A correct diagnosis of such localization demands a painstaking examination, a knowledge of the anatomy of the hand in its relation to infection, and a surgical sense which becomes sharpened by experience with this type of cases.

Infections of the palm of tne hand may be divided between those lying above the palmar fascia and those lying below it. Those which lie above this fascia usually present no difficulty in diagnosis unless they are associated with infection also involving the deeper structures. This paper will discuss the infections lying deeper than the palmar fascia.

Infection deep in the hand may be localized in one or more definite anatomical positions, and by all odds the most important diagnostic features in the recognition of such localization are, first, the local areas of tenderness; second, the pain elicited by passive movements of the fingers and hand; third, the history or presence of a wound which is probably the initial source of the infection.

Tenderness.—To examine carefully the infected hand for the areas of tenderness will tax the patience of the surgeon to the utmost, and requires that, first of all, the complete confidence and coöperation of the patient must be obtained. The examination must be done slowly and methodically. The greatest accuracy may be obtained by using just the tip of the right index finger for palpation, or, better still, a blunt instrument such as the end of a pen-holder or a dull pencil. The patient's hand should rest lightly in the hand of the examiner, palm up, or on a table. It is best to begin the palpation at some distance from the area which is suspected of being the involved one. For instance, if the infection is probably in the middle palmar space, begin the examination over the wrist, or over the palmar thenar space. In this way the examiner will obtain an index of the patient's susceptibility and the patient will be reassured. In no condition is the individual's susceptibility to pain and tenderness more of a consideration than in these cases. Some highly sensitive patients will react vehemently upon the gentlest manipulation, making a careful examination extremely difficult; while a stolid few may allow of such coarse palpation as to raise the doubt that infection can be present. Furthermore, it should be borne in mind that even though the infection may be definitely localized in a certain compart-

ment of the hand, the whole hand is more or less tender and it is not easy for the patient himself to give the physician a clear idea of its greatest intensity. In nervous patients the fear of having pain added to pain already intolerable will increase the sensitiveness of the individual to such an extent that the examiner must be careful not to be led away from the greatest localized tenderness by this apparently marked general tenderness. Tenderness will vary greatly, depending upon the acuteness of the infection—usually being very marked in the rapidly spreading virulent types and may be insignificant in those produced by organisms of low grade virulence.

Pain on Motion.—Characteristic is the position in which an infected hand is carried. It is with the fingers and thumb partially flexed at all the joints, and with the hand partially flexed at the wrist. This allows of the greatest relaxation of the muscles, and the least amount of tension between the tendons and their sheaths.

After the tenderness has been localized, gentle manipulation of the fingers and thumb must be made to determine what movements are painful and to what areas of the hand the maximum pain is referred. Here again it is best to begin with that finger the flexion and extension of which is likely to cause the patient the least amount of discomfort. As in the demonstration of tenderness, one must not be misled by the fact that pain is present on movement of all the fingers in some cases, but must discriminate between that which is more and that which is less intense. Increase of the partial flexion of the fingers will cause some pain, but extension is the movement which elicits the greatest amount, because it puts all the structures of the palm under tension. Each finger and the thumb must be examined separately, methodically, and, if necessary, repeatedly in order to determine accurately the relation of movements of the digits to pain.

The hand must then be examined relative to pain elicited by extension and flexion at the wrist, the former movement being more important than the latter.

Local Signs of Infection.—There may be a local wound, such as a puncture wound, hangnail, paronychia, etc., which will present evidences of inflammation and give a clue to the localization of the deeper, metastatic process. There is often some fulness in the palm of the hand, as shown by comparison with the sound hand, and may be evidenced only by an indistinctness in the lines of the palm. A very definite, diffuse bulging may be present, especially in children and in women, in whom the skin and palmar fascia is relatively thin and elastic. There is frequently an indefinite sensation of tension imparted to the palpating finger on examining the palm.

Œdema is usually limited to the back of the hand and is often so marked that the outlines of the knuckles are lost. Redness of this area is also present, and these two evidences of local inflammation are responsible for numberless incisions on the dorsum of the hand in cases in which not a drop of pus is present except in the palm. In marked contrast to the œdema and redness of the back of the hand is the relative absence of tenderness over this area.

These signs of redness and swelling vary with the localization of the infection in the palm and with the acuteness of the infection. Œdema and redness will sometimes be present on the palmar surface of the wrist in infections of the ulnar and radial bursæ. This is discussed later.

General Symptoms.—These vary as in pyogenic infection anywhere, and are of no distinct aid. In fact, their absence in low grade infections may cause one to distrust his local findings. I have seen a case in which over an ounce of pus was released from the ulnar and radial bursæ, in a patient who was observed for five days and who was denied earlier operation because the general symptoms of pyogenic infection were lacking.

Localization of Infection.—(*a*) *Ulnar Bursa* (Fig. 1).—Hand held semiflexed at wrist and with fingers and thumb partially flexed. Usually supported and elevated by well hand.

Tenderness, very severe in acute cases, is definitely localized over the ulnar bursa from the tip of the little finger to an inch above the wrist-joint, most marked usually in the region of the annular ligament and the wrist; less marked in the palm just distal to this ligament; usually associated with involvement of the radial bursa and tenderness over it.

Pain, very severe in acute cases, is elicited by extension of the little finger. This is referred throughout the extent of the tendon but its maximum intensity cannot be determined by the patient in most cases. On flexion there is also pain produced, but not so marked. Extension of the second, third, and fourth fingers produces pain referred to the palm of the hand, in *region* of the *carpus,* and wrist. Extension of the thumb will also refer pain to this region. Extension of the hand at the wrist causes marked pain referred to the wrist and proximal portion of the palm.

Redness is often present on the palmar aspect of the wrist just proximal to the annular ligament in the more acute cases, and when present is an extremely important sign of infection of the ulnar bursa. It extends across the wrist as a band about a finger's breadth in width, is somewhat œdematous, and usually very tender, superficially as well as deeply. Redness and soft œdema over the back of the hand is quite marked in acute cases and is uniformly distributed. Tenderness over this area, however, is slight. The presence of a local wound on the little finger, or a puncture wound in the palm directly over the bursa, will give a valuable clue to the localization of the infection.

(*b*) *Radial Bursa* (Fig. 1).—Tenderness very acute, and definitely localized over the tendon of the M. flexor pollicis longus from the tip of the thumb to about two fingers' breadth above the wrist-joint. Tenderness merges with that of the ulna bursa in the proximal portion of the palm in cases in which both are involved, which is the rule. One must be careful to differentiate the tenderness over the radial bursa from that over the palmar thenar space.

Severe pain produced by extension of the thumb referred along the entire tendon into the forearm. Severe pain also elicited by extension of

FIG. 1.—Areas of tenderness in infection of the ulnar and radial bursæ. The more marked areas of tenderness are shaded darker.

FIG. 2.—Area of tenderness in infection of the middle palmar space.

FIG. 3.—Area of tenderness in infection of the palmar thenar space.

FIG. 4.—Area of tenderness in infection of the dorsal thenar space.

FIG. 5.—Showing the skin incisions for drainage of the ulnar and radial bursæ.

FIG. 6. — Showing the incisions for drainage of the middle palmar space and the palmar thenar space.

FIG. 7.—Showing the incision for drainage of the dorsal thenar space. The dorsal aspect of the middle palmar space incision is also shown.

the hand at the wrist, referred to the region of the carpus. Movements of the second, third, fourth and fifth fingers will produce comparatively slight pain, and it will be referred to the region of the annular ligament and wrist. Œdema and redness over the palmar aspect of the wrist may be present. Over the back of the hand it is relatively slight and greater over the radial half than the ulnar. The presence of a wound of the thumb should make one suspect infection of this bursa.

Infection of low grade virulence will sometimes become walled off in a limited area of either the radial or ulnar bursa by adhesions forming between the synovial lining of the sac and that of the tendon. Practically this only occurs in those portions of these bursæ which lie in the thumb and little finger. Infection which gains access to the expanded portion of the bursa tends to spread rapidly throughout the entire sac.

(*c*) *Middle Palmar Space* (Fig. 2).—Tenderness is definitely localized over the area in the palm which this space occupies. This is usually not such an acute tenderness as is found over the ulnar bursa in infection of the latter. It extends only up to the annular ligament and is not present in the wrist. It is not present over the little finger and extends distally only to the transverse palm crease except where the space is prolonged along the lumbrical muscles of the third, fourth and fifth digits. Here the tenderness is often quite superficial.

Pain is elicited by extension of the middle and ring fingers. This is usually not very severe and is referred to the *middle of the palm.* Extension of the index and little fingers will produce pain relatively slight and referred also to the mid-palmar region. Extension of the wrist will cause only slight pain if the fingers are flexed, but if the fingers are extended either before or after extending the wrist, the pain will be severe and will be referred to the middle of the palm. Swelling and redness on the dorsum of the hand is usually quite marked and extensive. Tension and even bulging of the tough palmar skin is often distinct.

An infected wound of the middle or ring fingers, or one directly over the space, especially a punctured wound, often gives the first clue to the diagnosis. Emphasis must be made on the fact that infection in the mid-palmar space tends to early invade the palmar thenar space and *vice versa.*

(*d*) *Palmar Thenar Space* (Fig. 3).—Tenderness is localized in the palm over the space. It does not extend above the annular ligament nor onto the thumb. The extension along the lumbrical muscle of the index finger may often be definitely mapped out by the tenderness.

Pain is elicited by extension of the index finger and is localized in the palm just below the greatest prominence of the thenar group of muscles. Relatively slight pain is produced by movements of the remainder of the digits. Extension of the wrist produces no definite distress unless the index finger is at the same time extended.

Bulging in the radial half of the palm is often present and is quite diagnostic of infection in this space, and there may be redness over this area.

Œdema and redness on the back of the hand is present and is most marked over the radial half, especially between the thumb and index finger. An infection of the index finger is often the predisposing factor in infection of this space.

(*e*) *Dorsal Thenar Space* (Fig. 4).—Tenderness most marked on the back of the hand between the first and second metacarpal bones, and over this area there is usually a marked bulging and redness and œdema. Relatively less tenderness is present on the palm over the same area but extending also ulnarward nearly to the middle line of the palm. Pain is best elicited by abduction of the thumb and is referred to the web of the thumb. It is usually not marked.

Infection may spread to involve two or more of these bursæ or spaces, and if so, the diagnosis must be made of such involvement. Bearing in mind the anatomical relations between these various structures and the routes by which infection tends to spread as shown experimentally and clinically (Beye: ANNALS OF SURGERY, July, 1917), this is usually not difficult. To the area primarily involved are added the local symptoms of that secondarily infected as shown especially by the tenderness, and to a less extent by the pain of movement.

Treatment.—No attempt will be made to summarize the different methods of treatment which have been advocated by different surgeons. The methods which will be outlined in this paper have been worked out from study of clinical cases and anatomical preparations.

Deep hand infections should be treated as emergency surgical cases and operation must be performed as soon as possible after diagnosis is made. A delay of only a few hours may make a great difference in the extent of the infection. If there is a doubt in the mind of the surgeon as to whether infection is present in a certain space, it is safer to explore that space than to wait to see what is going to happen. Especially is this true if one is dealing with an acute infection. If an exploration is made of a space in the hand, and no pus is found, the chance for carrying infection into the space by the operative procedure is relatively slight.[1] If a space is watched for several

[1] Since writing this paper the following case has come under observation, which shows that exploration of an uninfected space is not without danger. Patient brought to hospital with a hand infection of four days' duration. Began within a few hours after a punctured wound of the thumb from the spur of a rooster. Diagnosis or infection of the radial and ulnar bursæ with extensive cellulitis of the forearm nearly to the elbow was made. Tenderness in the palm seemed more extensive than that produced by infection only of the ulnar bursa and seemed to extend into the mid-palmar space area. Exploration of this latter space was done and no pus was found. The opening was carefully packed with iodoform gauze and the ulnar and radial bursæ, which were filled with pus, then drained. The tough compact subcutaneous tissue around the exploratory incision for the mid-palmar space became mildly infected about the eighth day and this extended to involve the theca of the ring finger, and this bursa had to be widely opened. Notwithstanding this unfortunate result from an exploration I believe that the principle remains the same, *i.e.*, that in acute hand infections exploration of doubtfully infected spaces is less dangerous than waiting to see what is going to happen.

hours, and it already contains pus, considerable damage may be done during the delay.

A general anæsthetic should be given in the vast majority of cases, because complete relaxation is essential to careful work, and ether is by all odds the anæsthetic of choice. Nitrous oxide and oxygen may be given satisfactorily by a skillful anæsthetist.

A constrictor should be used unless there is a contra-indication to its use. It allows of careful scrutiny of the blood-free tissues and the detection of small amounts of pus which might be easily overlooked. Its use is contra-indicated if there is a lymphangitis which extends up as high as the elbow or above. The most common complication attributable to its use is a thrombophlebitis of the superficial veins of the forearm.

Tincture of iodine is used to render the entire hand and forearm aseptic. In all cases the operative procedure should be carried out carefully, methodically and along certain definite lines.

Ulnar Bursa (see Fig. 5).—An incision is made parallel to the flexor tendons to the little finger and directly over them at the point of greatest tenderness in the palm. As the deep palmar fascia is divided it will often appear distinctly œdematous—a reassuring evidence of trouble in the deeper bursa. As the latter is come upon it may be distended and tense by the accumulation of pus within it. In the early cases, however, it may only appear lusterless, or there may be no evidences from the outside, of trouble within it. Make a small incision in the bursa, taking care not to injure the synovial lining of the tendon, and frequently pus will at once roll out from it, or at least a cloudy, sticky fluid. The latter type of exudate is characteristic of a very acute streptococcic infection in the early stage.

In some cases there is no evidence of exudate or pus upon opening the bursa, to the dismay of the operator. Gently strip the ulnar bursa, beginning in the forearm and continuing distally to the opening which has been made in the bursa. This will produce pus if present in the bursa in the wrist and forearm. Similarly pressure upon the distal portion of the bursa will demonstrate the presence of pus here.

As soon as free pus in the bursa has been demonstrated, the latter must be widely opened. Remember that the tendon of the fifth finger is the guide to the bursa and that the tendon may be easily mapped out by bearing in mind its relation to the uncinate process around which it swings as it passes from the wrist to the palm of the hand. This bony landmark is readily palpable.

First extend the incision through the *skin* and *tough subcutaneous tissue* from the distal phalanx of the fifth finger to a finger's breadth proximal to the annular ligament in the wrist, exposing the ulnar bursa and the annular ligament where the bursa passes behind this ligament in the wrist. Then carefully open the bursa where it lies over the flexor tendons of the fifth finger, by enlarging the small incision which was previously made in it, from the distal phalanx to the distal border of the annular ligament, leaving a narrow strip of the bursa intact at the levels of the metacarpophalangeal joint

and the first interphalangeal joint, where the bursa is reinforced by a tough band of deep fascia. These intact strips prevent prolapse of the tendon in the finger, with subsequent better function.

How to take care of that portion of the bursa which lies under the annular ligament is always a question. At the proximal margin of the annular ligament there is just a very small bit of the bursa which extends anterior to the tendons and that is on the ulnar side. The greatest portion of the bursa lies behind the group of tendons. But under the ligament as the palm is approached, more and more does the bursa tend to extend anteriorly. Whether the annular ligament should be cut through or not will depend upon several factors. I do not believe that it should be done in all cases. Unquestionably by completely incising the ligament better drainage is obtained, but in many cases sufficient drainage is gotten by leaving the ligament wholly or partially intact. The disadvantage in incising completely the annular ligament is the danger of prolapse of the tendons. This may be guarded against by dressing the hand in extension as has been advised, but by so doing the tendons are pressed firmly against the posterior wall of the bursa and tend to dam in the pus, thus defeating the purpose of this manœuvre. Furthermore there is no doubt that healing takes place with greater danger of scar interference in those cases in which the ligament has been incised. In a given case, however, there should be no hesitancy in doing this more radical procedure if there is the question of insufficient drainage on the one hand, and that of scar formation or tendon prolapse on the other.

(1) Leaving the annular ligament intact. This may be done in acute cases which have been gotten early and in which there has been only a small amount of pus formed, or in which the pus is thin and readily drainable. It may be done in those cases in which the bursa extends well up into the wrist *anterior* to the flexor tendons, for in these a considerable drainage may be established by incision proximal to the ligament. In low grade infections this may be sufficient unless the pus is very thick, as is frequently the case. That portion of the bursa lying proximal to the ligament and anterior to the tendons should always be opened, whether the ligament be wholly or partially incised or left intact. To do it a grooved director is passed into the opened bursa just above the tendons of the little finger at the distal border of the annular ligament, and guided under the latter toward the wrist. Care must be taken not to use too much force so as to injure the tendons. The bursa proximal to the ligament may thus be opened on the director.

(2) Cutting the annular ligament. This may be done partially or completely, depending upon the necessity. In acute cases with formation of considerable pus which seems to have accumulated under the annular ligament, in cases in which the bursa does not extend proximal to the ligament anteriorly, and in neglected cases in which involvement of the carpal joints and bones is feared, then the annular ligament should be cut in some degree depending upon the condition present. The preservation of even a small

portion of the ligament should always be done where deemed advisable. It will aid in maintaining the " status quo."

To do it, a grooved director is passed from below up, under the annular ligament, and the incising done upon it. In those cases in which the ligament is completely incised, the whole tendon group may then be very carefully lifted out from its carpal bed and the pus lying under it gently sponged or washed away. Rough handling must be avoided, because of the sensitiveness of the synovium.

Drainage of that portion of the bursa which lies *behind* the tendons in the wrist and forearm must now be made, and here is found the greatest amount of pus in most cases. An incision is made on the ulnar side of the forearm hugging the anterior surface of the ulna. This begins at the level of the wrist-joint, extends up the forearm for about 2½ inches, passing through the skin and fascia to the bone. Then a pair of sharp-pointed hæmostats is forced through the incision, keeping close to the bone and under the flexor tendons, and passed toward the palm directly into that portion of the ulnar bursa which is so intimately related to the carpus. Then the forceps are spread and withdrawn and the pus will roll out along them.

When both ulnar and radial bursæ are involved the radial bursa is drained by a similar incision made along the radius, which will be described later, and then through and through drainage is instituted through the bursæ, by passing a hæmostat from the ulnar incision to the radial incision under the tendons. Drainage is maintained by the use of gutta percha tissue folded into strips. This material may be made to fit into the incision readily, is non-irritating and allows pus to escape along it freely. If it is not available, the next best is strips of plain gauze dipped into liquid paraffin. The incision in the hand is held widely open in its entire extent by laying into it, down to the exposed tendon, a strip of gutta percha. That portion of the bursa behind the tendons in the wrist and forearm is drained by two folded strips of gutta percha carried through the ulnar incision, one laid in the trough of the carpus without using force, and the other out through the radial incision upon the pronator quadratus muscle.

Radial Bursa (see Fig. 5).—In this case the mode of procedure is similar to that in infection of the ulnar bursa. It should be again emphasized that the branch of the median nerve passing to the thenar group of muscles must be spared, even at the expense of insufficient drainage of the bursa, with subsequent loss of the flexor tendon to the thumb. This nerve branch lies within a finger's breadth of the distal margin of the annular ligament.

Make an incision from the distal phalanx of the thumb to within a finger's breadth of the annular ligament through the skin and subcutaneous tissues directly over the tendon of the flexor longus pollicis. Remember that this tendon passes at an angle of 60 degrees around the trapezium with the thumb abducted. Retract the thenar muscles to the outside and open the radial bursa for the extent of the incision in the soft tissues. Make another incision about an inch in length on the anterior surface of the wrist proximal

to the annular ligament and incise the radial bursa at this point. The portion of the bursa lying behind the tendon in the forearm and wrist is drained by a lateral incision about 2 inches in length made along the anterior border of the radius. Through this incision a hæmostat is passed behind the tendon down into the carpal trough and the bursa widely opened.

These incisions are kept open by folded gutta percha strips laid down to the exposed tendon and the portion behind the tendons in the wrist is drained by a strip carried into it through the radial incision.

Middle Palmar Space (Fig. 6).—In the usual case this is best drained by the method first advised by Besley. Holding the middle and ring fingers widely apart, split the web between them to the level of the distal transverse crease of the palm anteriorly and posteriorly to the level of the knuckles. Then retracting the incision by spreading the fingers, carefully pass a hæmostat behind the tendons upward toward the annular ligament. Then gently spread the points of the forceps and withdraw. The pus will roll out along them.

If the infection has travelled down along the lumbrical muscle of the middle or little finger, then it is advisable to drain the middle palmar space by incising the web between the index and middle fingers or ring and little fingers respectively. In the latter instance care must be taken not to encroach upon the tendon of the little finger with the ulnar bursa surrounding it. In a very exceptional case it may be wise to incise into more than one web to provide adequate drainage.

The incision is kept open by a folded gutta percha strip which is very carefully carried to the depth of the space by a hæmostat.

Palmar Thenar Space (Fig. 6).—Make an incision beginning just above the web between the thumb and index finger half way between the thumb crease and proximal palm crease. Carry this obliquely upward and inward toward the point at which the flexor tendons to the thumb and index fingers diverge in the palm. The incision passes through the tough palmar skin and fascia to the M. adductor pollicis. This opens the palmar thenar space. A hæmostat is then carried through this incision toward the annular ligament, keeping behind the flexor tendons of the index finger, and withdrawn with jaws spread. Drainage is maintained by a gutta percha strip laid in the incision and carried to the highest point of the space.

Dorsal Thenar Space (Fig. 7).—Incision is made on the dorsal surface of the hand beginning just above the web between the thumb and index finger and carried up for about one inch parallel to the first metacarpal bone. This exposes the margin of the first dorsal interosseous muscle and a forceps is inserted just anterior to this muscle and behind the M. adductor pollicis and carried in deeply to the depth of the space; *i.e.*, the level of the origin of the latter muscle from the third metacarpal bone. Drainage is maintained by a gutta percha strip.

If more than one compartment of the hand is infected, it will be necessary to drain each involved area. This is very important, as so frequently

an infection which has primarily attacked one space will have subsequently spread to one or more others, and drainage of that primarily involved will not be sufficient to take care of those secondarily involved. To many surgeons the incisions as outlined above seem very radical, whereas, early, free, complete drainage of an infected hand along definite anatomical lines is in reality conservative surgery. I can conceive of no condition in which through and through tube drainage of the hand would be indicated.

After the necessary incisions have been made and the gutta percha drains placed, then the constrictor is removed. There is free oozing of blood, but it is rare that a ligature must be applied, for the bleeding soon stops. If the annular ligament has been completely incised then dress the arm on a dorsal board splint with the wrist and fingers held flat against it so as to prevent prolapse of the tendons. Where the ligament is completely or partially intact a splint is not desirable, but the thumb and little finger should be kept straight by the dressings and bandage. Hot boric dressings are applied to the whole hand and forearm, care being taken not to cramp the fingers by the dressing or bandage, as this causes a great deal of discomfort. They should be kept hot and moist by repeated irrigation.

After Treatment.—Hot, moist dressings are usually discontinued after forty-eight hours and are replaced by plain gauze dressings spread thinly with sterile vaseline to prevent injury of the granulations. In applying the bandage to the dressing the unincised digits should be left free so as to allow active and passive movement of them, as well as giving the patient more comfort. The drainage material is removed also at the end of forty-eight hours, for if the incisions have been ample there will be sufficient drainage through them from now on. Particularly in the infections of the radial and ulnar bursæ it is desirous to remove the drains just as soon as possible, so as to obviate any danger of injury to the synovial lining of the tendons by pressure from the drains.

Beginning on the third day, the hand is soaked every day for fifteen minutes in a hot bath to which is added tincture of iodine. At first just enough of the latter is added to color the water, and each day more is added so as to make the soaking more stimulating to the granulating areas. As early as the third day, while the hand is soaking in the hot iodine solution, passive motion of the fingers is very gently begun and the patient is encouraged to attempt active motion. This is continued each day, more and more force being used, but always being careful not to do more harm than good by excessive injury to the granulation tissue. In infection of the ulnar and radial bursæ, early mobility of the second, third and fourth fingers must be worked for, for the fingers are often annoyingly stiff, due to long continued immobilization as well as the inflammation of the bursæ.

It should be emphasized that an infected hand which has been drained should be examined carefully each day in order to make sure that all of the infected areas have been opened and that the drainage has been ample. If an infected area has been sufficiently drained, tenderness should no longer

be present over that area. If tenderness develops over a space which has not been drained, involvement of that space must be at once suspected. The pulse, temperature and leucocyte count are valuable adjuncts as they are in infection in any part of the body. But in an old, neglected hand infection, pus may be present or may even spread to involve a new area without variation in the pulse, temperature or leucocytes giving a clue.

Prognosis.—When the ulnar and radial bursæ are drained for infection throughout their extent, there is never a 100 per cent. recovery of function. Interference with function varies, naturally, with the time which elapses between the onset of infection and the drainage of the bursæ; whether there is loss of tendon, involvement of the wrist or carpal joints, whether the annular ligament was incised, and the will of the patient to work the hand during convalescence.

One of the end results which may occur even under the best conditions of treatment is contracture of the little finger. There is always stiffness of the finger at least. If the contracture is at all marked, amputation is the best treatment. Lesser degrees may be treated by excision of the scar in the finger and portion of the palm with transplantation of a Wolff or pedicle flap. The end result after such procedure is only fair.

Contracture of the thumb is usually less marked than that of the fifth finger, and would almost never call for amputation.

Return of function after uncomplicated infection of the middle palmar, palmar thenar or dorsal thenar space may approximate 100 per cent.

BONE TRANSPLANTATION IN THE SURGICAL TREATMENT OF PARALYTIC FEET

By Joseph E. Fuld, M.D.

of New York

INSTRUCTOR IN OPERATIVE SURGERY, COLLEGE OF PHYSICIANS AND SURGEONS, COLUMBIA UNIVERSITY; ASSISTANT VISITING SURGEON, GOUVERNEUR HOSPITAL

The object of this operation is to secure bony ankylosis and so assure stability and prevent lateral deformity of a flail ankle, fixing it in a position of equilibrium midway between flexion and extension. This is done by inserting a bone graft which passes through both malleoli and the body of the astragalus.

While numerous operations have been devised for improving the function of paralytic feet, the end-results have been unsatisfactory. It is irrational to expect that a mere shortening of tendons which often are so stretched out, leaving only a thin membranous structure, will cure a deformity so complex. Tendon transplantation has proven disappointing in not fulfilling expectations, relapses occurring in a few years with the return of the deformity. Arthrodesis alone of the ankle-joint, in my opinion, is an operation yielding, at the best, an imperfect result and should not be encouraged. To increase security of the foot, in paralytic feet, Whitman advises arthrodesis, astragalectomy, tendon transplantation, and backward displacement of the foot. Goldthwait has evidently been unsuccessful with arthrodesis alone; he, in an attempt to secure a closer fitting of the parts, performs an oblique osteotomy of the lowest part of the shaft of the fibula. The lower end of the fibula is then bent inward and pressed against the external articular surface of the astragalus.

To prevent recurrence of the deformity, I devised the method of bone transplantation which will be described presently. My first case operated by this method was on October 9, 1915. The patient, Fannie R., aged nine years, had suffered from infantile paralysis for six years, affecting the muscles of the left leg. The plaster cast was removed at end of 8 weeks. Primary union, foot firmly ankylosed at angle in normal position. The operative technic for the proposed procedure is as follows:

1.—Prepare foot and leg for operation and apply an Esmarch bandage.

2.—Place the outer side of the foot on a sand bag.

3.—A short curved incision is made passing from a point behind the internal malleolus, below its extremity, and terminating in front of it.

4.—The limb is now turned over, the inner side resting on the sand bag, and a second incision is made passing from a point behind the external malleolus, below its extremity, and terminating just below and in front of the joint. The joint is then opened and the foot displaced inward. This forces the astragalus from between the malleoli. The cartilage on its upper

and lateral surfaces is then removed. The foot is now forced downward, and the articular surfaces of the tibia and fibula are likewise removed.

5.—A hole is made with a quarter-inch drill passing through both malleoli and the body of the astragalus.

6.—Measure the length required for the bone graft by inserting a flexible probe into the canal just made, marking by bending it at a right angle.

7.—With a chisel or motor saw remove the needed bone of the measured length and thickness from the upper third of the anterior internal surface of the patient's tibia. The graft must be of sufficient thickness to necessitate a moderate amount of force to insert it into the canal, since bone will only unite when it comes in intimate contact, otherwise granulation tissue appears on the wall of the canal, interfering with nutrition and predisposes to the absorption of the bone graft.

8.—Insert bone graft into canal ready to receive it.

9.—Suture the anterior and lateral ligaments, then close the wound with catgut.

10.—Plaster-of-Paris fixation dressing from eight to ten weeks.

The advantages of this operation are: (1) The three bones of the ankle are fixed by one bone graft. (2) It is much simpler and easier of execution than other operations known for this condition. (3) It is less mutilating. (4) It does not injure the epiphysis of the tibia as does the bone graft insert of Lexer, who advises a graft which passes through the os calcis, astragalus, and tibia. (5) It preserves the joint between the os calcis and the astragalus, thus allowing some degree of mobility.

FIG. 1.—*A* and *B*, showing position of bone graft passing through both malleoli and the body of the astragalus.

FIG. 2.

NOTE ON TUBERCULOSIS OF THE SPINE

By James A. Honeij, M.D.
of New Haven, Conn.
Assistant Professor of Medicine in Charge of Radiology, Yale University

The opportunity for studying vertebral tuberculosis in a patient before the bones are attacked and after pathological changes have occurred is not often presented. The following case is therefore of interest in this respect.

Case History.—E. W. entered hospital August 16, 1915. Age, forty-four. Female; married. Provisional diagnosis, ***movable kidney.***

History.—Pain in small of back and right side of abdomen. Began about three and one-half months previously with sudden onset. Pain over right kidney and in right side of abdomen. Pain severe and of a few days' duration. Incontinence of urine and nocturia. Also blood-tinged urine with some mucus. Condition gradually improved. After being in bed for three weeks pain was less severe. Up to two weeks ago patient was up and about. Second attack, similar to the first, then occurred. Pain was more severe and definitely localized over right kidney and right side. Frequent micturition.

Family History.—Father died at thirty-nine years of age of tuberculosis of stomach. Mother died at age of forty-one of pulmonary tuberculosis. One brother died of stomach trouble at forty-five. Husband and two children living and well.

Past History.—Has never been strong, although not troubled with any disease; subject, however, to sick headaches for many years. Some shortness of breath for the last two years. Bowels have always been constipated. Has also complained of rheumatism in the extremities for several years. Catamenia normal. Best weight 98 pounds, two years ago.

Present Illness.—Since onset of present illness has had night sweats but no cough. Present temperature 99.8°; pulse 90; respiration 20.

Physical Examination, August 17, 1915.—Left side of abdomen negative. Right side, lower quadrant, just below McBurney's point, a localized area of tenderness without muscular spasm. Right kidney movable, readily palpable and tender. No abdominal distention. Posteriorly, marked tenderness in both costovertebral angles extending down the lumbar muscle. Facies indicates loss of weight.

Cystoscopic Examination.—Meatus small. Left side, normal flow of clear urine; right side, delayed flow of clear urine.

Operation, August 27.—Right kidney low and movable. Definite perinephritic kidney being adherent to posterior peritoneum. No stone in kidney or ureter. Liver and large bowel very low; liver opposite anterior superior spine. Long, thick, chronically inflamed appendix. Left kidney normal. General visceroptosis. Wound closed; no drainage.

September 9: Wound practically healed.
September 15: Incisions completely healed.
September 19: Discharged, apparently cured.

Patient readmitted to Dr. John W. Churchman's service June 1, 1917. Diagnosis, *tuberculosis of the spine.*

History of abscess and later discharging sinus in kidney region and back trouble. After being discharged from the hospital in September, 1915, felt fairly well, excepting for rheumatic pains about the waist and appendix region. Shortly after operation patient began to notice that her back was "getting out of shape." In January, 1917, began to have trouble in using her legs. Had pains, and a short while ago her heels began to feel numb. On urination had definite sharp pains in her side. In January, sinus opened at the site of the old wound; has been discharging since. Complains of indigestion. Constipation. No loss of weight. No cough or expectoration.

Physical Examination.—Shows a rather poorly developed and nourished middle-aged woman. Color of face is high, but skin is generally pale. Conjunctiva of eyes pale. Tongue slightly coated. Moderate gingivitis present. *Teeth*—upper, false; lower, fairly good. *Neck*—chains of shot-like glands in cervical region; palpable; most marked on the left. Axillary glands size of cherries—easily palpable. Epitrochlear glands palpable and inguinal glands moderately enlarged. *Thorax*—small, round and long. Ribs and clavicle prominent. Expansion is slightly better on the right than on the left. Left supra- and infraclavicular fossæ prominent. Left apex narrowed and dull posteriorly down to spine of scapula and in front to the second rib. No definite râles. Breath sounds slightly diminished and slightly harsher over the left apical region. Lungs are otherwise hyperresonant. *Heart* negative. *Abdomen* natural; scars from previous operation. No masses over areas of tenderness. *Spleen* slightly enlarged. *Liver*—normal size; sixth rib to 1 cm. below costal margin in right midclavicular line. No palpable mass. *Kidneys* not palpable. In right lumbar region, in old kidney operation scar, is a small sinus discharging thick yellow pus. Marked tenderness over lower ribs and posteriorly over both kidney regions. Back shows small gibbus opposite first lumbar. Region quite tender. *Extremities*—no paralysis. Feet and hands cold and sweaty. Feet cyanotic.

Neurological Examination.—Knee jerks and plantar reflexes present but not lively. No Babinski or Kernig. Sensation of lower extremities somewhat modified. Posterior and lateral surfaces of both thighs, legs, outer half feet, and ankles show diminished sensation to touch. Pain sense and heat sense diminished on outer part of dorsa of feet and over an area the size of a hand, just back of the trochanters.

Patient referred for röntgenological examination on June 2, 1917. *Diagnosis,* tuberculous kidney (right). Pott's disease. *X-ray Diagnosis* (Fig. 2).—Just below the right kidney region, opposite the psoas muscle and opposite the third lumbar intervertebral space, there is an area 3 cm. long and approximately 1 cm. wide, the density of which is similar to bone. There are several other smaller opaque

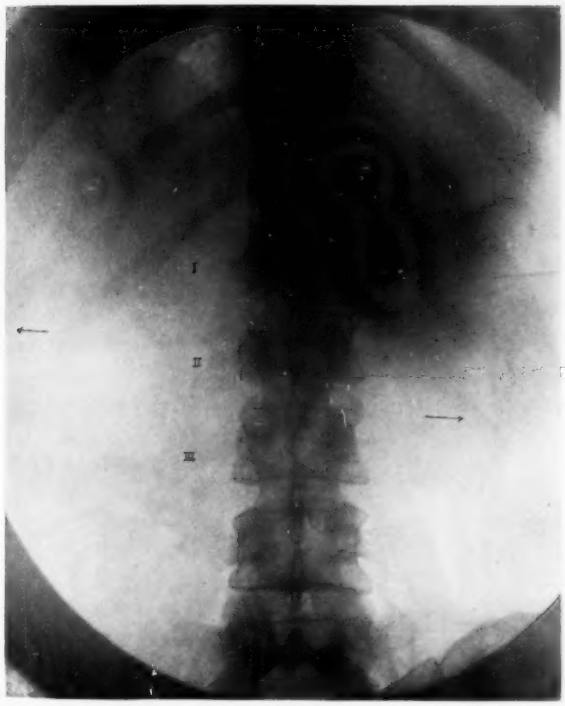


FIG. 1.—Röntgenogram taken August, 1915, shows normal vertebræ (I, II and III). Arrows point to areas of calcification.

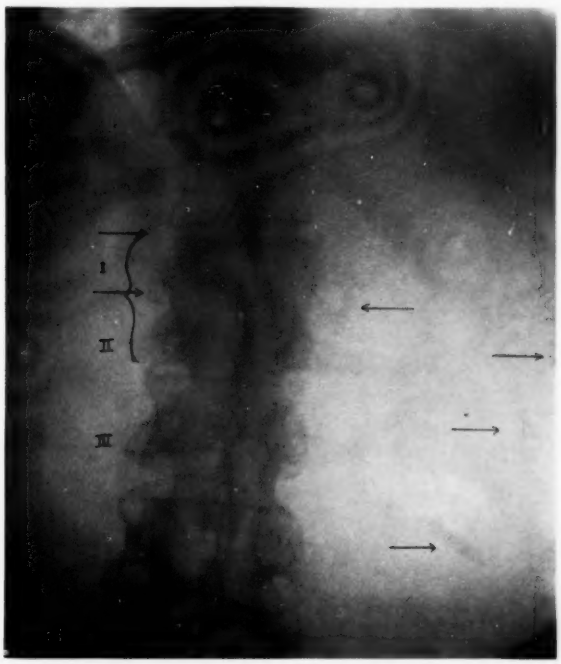


FIG. 2.—Röntgenogram taken June, 1917 (twenty-two months later), shows destruction of vertebræ (I and II). III and IV show rarefaction changes. Arrows point to areas of calcification. Right lower arrow shows the same area of calcification mistaken for calculus; marked calcification surrounding destroyed vertebræ.

areas at the ends of the ribs and at the outer borders of the first and second lumbar vertebræ. The left kidney region shows a more or less similar condition. A–P view of the spine shows a marked bony change in the first and second lumbar vertebræ. There is apparently complete destruction of the body of the first lumbar vertebra with absorption of bone substance and irregular redeposit of bone salts. Lateral view shows a greater destruction of the anterior portion of the first lumbar. There is also destruction of the upper and anterior portion of the second lumbar. The whole spine shows a marked kyphosis at the first lumbar vertebra.

The chest shows an increased density throughout both lungs. The bronchial markings are much increased in density and width. There are definite calcified tubercles and mottling extending everywhere. Both apices show the greatest density. There are definite calcified glands in the region of the hilus and in the neck.

These röntgenograms were compared with the röntgenograms made in August, 1915, previous to operation (Fig. 1). The areas in the kidney region are as described in the present examination—perhaps slightly smaller and less abundant. The vertebræ in 1915 show absolutely no changes and would be considered normal.

Diagnosis of the present condition is unquestionably that of tuberculosis—probably miliary.

In the case under observation there are several other points to be noted. Tuberculosis of the vertebræ occurred by extension from a neighboring lesion aggravated by operation on a tuberculous kidney. In the large majority of cases the vertebræ from the eighth or ninth dorsal to the third or fourth lumbar are most often attacked, and the process when seen by röntgenological examination is advanced, either showing as a more or less fusiform enlargement covering two or more vertebræ with increased density over the vertebræ (this is the so-called "condensante" form), or showing destruction of bone with obscurity of outline and detail and with obliteration of the intervertebral spaces, and adjacent rarefying changes. In the first type the fusiform enlargement is the result of tissue reaction—granulation tissue formation—as the process begins superficially, then new growth and formation of bone predominating at the level of the periosteum. In the second type the changes are rapid, especially in the adult, with slight, or no, external tissue reaction. The extremely favorable cancellous nature of the vertebral body with its abundant blood-vessels favors absorption with resulting rarefying changes, irregular surface erosion, vascular changes giving rise to caseous lesions and then mechanical forces which cause anterior compression, collapse and deformity (see Figs. 3 and 4).

These last changes are seen in this case and the rapid progress of the disease is evident. There is also seen here an external bone reaction with irregular deposits of lime salts immediately around the affected vertebræ and with unusually abundant lime salt deposits in the sternal portions of the ribs—especially in the ends of the last ribs on both sides—as well as

in the cervical, axillary and bronchial glands and the renal regions, suggesting a similarity to metastatic calcification.

The other classical features are not lacking here, such as abscess formation and failure to heal. The examination also reveals a pulmonary and gland tuberculosis. A tuberculous family history is given. Surgical trauma was a factor.

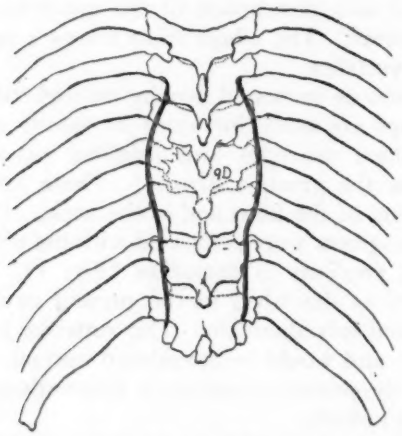


FIG. 3.—Illustrates a case of fusiform type of tuberculosis involving the seventh, eighth, ninth, tenth and eleventh dorsal vertebræ, especially the ninth and tenth. (Drawing made from röntgenogram.)

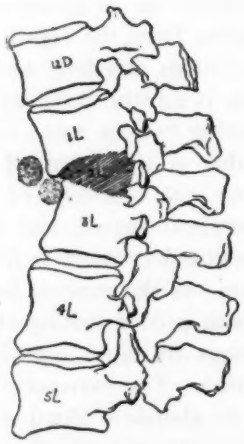


FIG. 4.—Shows destructive type of tuberculosis affecting part of the first, all of the second, and part of the third lumbar vertebræ. (Drawing made from röntgenogram.)

Lannelongue's assertion that bone lesions most often have a visceral lesion is here borne out.

One may conclude from this case that the diagnosis of renal calculi was based originally on the areas of calcification in the right renal region, but which, on closer study, are shown also on the left side and in the distal

ends of the last two ribs. Failure, therefore, to make proper diagnosis resulted in operation. The operative finding of "definite perinephritic kidney being adherent to posterior periosteum" points to inflammatory changes which were undoubtedly tuberculous in origin. The lighting up of this focus gave rise to the bone lesion. It may be pointed out that except in diseases where bone destruction is great, the redepositing of lime salts in tissues usually free is seen most frequently in case of tuberculosis. Renal pain, when occurring unilaterally, is often referred to the side free from disease and is therefore of less value than the röntgenological evidence. In cases similar to the one presented here the presence of calcified areas indicates at least further examination to determine whether tuberculosis can be ruled out. Two facts, röntgenologically speaking, are to be borne in mind: the renal region is not fixed and the opaque areas in the renal region do not always mean calculi. The following case is added to emphasize this:

> Female, aged thirty-five, with the diagnosis of pulmonary tuberculosis and bilateral renal tuberculosis, was admitted to Dr. Willis E. Hartshorn's service. The history was that of pain in the left side for several years which has become very severe during the last three months. Loss in weight, 25 pounds. Cystitis for the last three weeks. Physical examination gave pain and tenderness over left kidney. Left kidney easily palpable. Right kidney is 3 cm. below rib margin and slightly tender to pressure. The chest examination is omitted. The patient was referred for röntgenological examination. Röntgenogram of lungs suggests tuberculosis. Röntgenogram of renal region on the left is negative; on the right, opposite the third lumbar vertebra and 4.5 cm. from the outer vertebral border, is an opaque area—approximately 7.5 by 4.5 in diameter—with a vague inner outline but with a definite semicircular outer outline. Ureter catheters were inserted and röntgenograms repeated, which showed the left ureter to be in normal position and outline and to extend to opposite the first lumbar vertebra, approximately 3.5 cm. from vertebral border (normal position); the right ureter showed a less normal outline and stopped opposite the third lumbar vertebra, 3 cm. from the vertebral border, 3 cm. from the opaque area previously described. Diagnosis of pathological kidney was made, probably tuberculous. Exploratory operation advised. Examination for acid-fast bacilli advised. Patient was cystoscoped, cloudy urine obtained from right ureter. Acid-fast bacilli found.

It is suggested, therefore, that in such cases follow-up treatment be instituted. Had this patient (E. W.) been reëxamined at three-month intervals, the bone changes described, as well as the other visceral changes, could have been determined by röntgenographic methods.

THE GENERAL PRINCIPLES OF TREATMENT OF WOUNDS OF THE KNEE-JOINT FROM PROJECTILES IN WARFARE

By Charles Greene Cumston, M.D.

of Geneva, Switzerland

privat-docent at the university of geneva

The experience of the present war, an experience of now three years, has completely overturned the practice of former recent wars, and this statement applies very particularly to wounds of the large joints from rifle bullets and artillery projectiles. Wounds of the knee-joint represent from 3 to 4 per cent. of major injuries inflicted in battle, and that they are serious can be best judged from the fact that the resulting mortality may be placed at about 18 per cent. This gravity is increased on account of the numerous complications to which the knee-joint is particularly exposed, such as secondary hemorrhage, thrombophlebitis, gas gangrene and sepsis.

The anatomical varieties of wounds of the knee are many, but may be roughly classified as follows: (1) Seton or tunnel wounds without fracture, the bullet passing directly through the joint or remaining free within. This latter event is not common. (2) Wounds with fracture of one of the bones composing the joint, such as crushing of the tibial plateau, crushing or comminuted fracture of the patella or the femur, one or both condyles being broken off or crushed. (3) Wounds resulting in fracture of both tibia and femur, usually accompanied by fissures extending into the knee-joint. (4) Wounds with crushing of the articular surfaces, frequently with extensive destruction of the surrounding soft structures.

I am convinced that certain surgeons are prone to amputate with far too great a readiness in wounds of the knee, particularly when there is fracture, as is usually the case, as they fear the advent of a suppurating arthritis which cannot be overcome by arthrotomy or resection, and as they assume that the sepsis cannot be controlled they amputate, if not at once, at all events very soon—that is to say, within four or five days following the receipt of the injury. Now, this practice is bad and can only be condemned.

When should amputation be resorted to? To this question the answer is easy. Amputation is absolutely and unquestionably indicated (1) when there is crushing of the knee-joint or when the surrounding soft structures and bones forming the joint are so destroyed that they cannot be saved; (2) when there is a wound of the knee with injury to the large vessels in the popliteal space, but ligature may first be done if this is possible and an attempt made to preserve the limb, although *generally* the result will be unsuccessful; (3) *immediate* amputation must be done when there is gangrene of the leg, or when a *purulent arthritis is complicated by secondary hemorrhage from the popliteal artery* as occasionally happens. Never try to ligate in these cases; you will surely lose your patient.

The important principle to follow is to disinfect the wound and then obtain thorough drainage and immobilization of the joint. This is accomplished by arthrotomy with removal of the projectile in cases of wounds without fracture. The technic will vary with the preference of the operator, but I advise you to resort to the U-incision or a long external incision, this particularly when the projectile is retained in the joint.

Typical subperiosteal resection, according to the teachings and technic of that great master of bone surgery, the late Professor Ollier of Lyons, should almost always be done *as soon after the injury* as possible: by this I mean within the first twelve to twenty-four hours; but if an important portion of the articular surface can be preserved *without interfering with free drainage,* one may occasionally perform an atypical resection. But I repeat that a typical resection is the only proper treatment in the vast majority of cases. By resection the entire wound is cleansed of all bone splinters and bits of clothing and projectile are removed, so that when the operation is completed the wound is as aseptic as is possible to make it, and if the after treatment is properly carried out the recovery will be rapid and devoid of any disagreeable surprises or complications. *Never suture the wound after resection; leave it open without a single stitch being taken.* Immobilization will be obtained by a proper plaster case which will be described farther on.

Penetrating wounds of the knee-joint by projectiles without lesions of the articular ends of the bones, the projectile having made its exit from the joint cavity, have been relatively frequent, although seldom met with other than in this joint. Simple capsular injuries without damage to bone are not uncommon, the bullet passing through the suprapatellar pouch or the intercondylar notch, sometimes transversely behind the ligamentum patellæ if the joint is flexed at the time the projectile strikes. When seen within the first twenty-four hours after receipt of the injury, the knee is already swollen and an entrance and exit wound will be found diametrically opposite each other. The first thing to do is to take the patient's temperature, the result being that we have one of two conditions, viz.: (1) A wound of the knee with two apertures and apyrexia, or (2) a wound with two apertures with a rise in temperature.

When there is apyrexia it is *probable* that the lesions to the joint are not serious, and rest in bed, compression and immobilization in a fracture gutter will soon cause the swelling to disappear. If at the end of three to four days the intra-articular fluid collection, which is due either to a reaction of the synovial or to lesions of its vessels, has not become absorbed, it is preferable to empty the joint. Never use an aspirating needle for this, because the trocar will surely become obstructed by the gelatinous fluid or blood-clot which forms the collection and the inevitable result will be that the fluid contents is not withdrawn and probably you will infect the joint at the same time. Therefore, make a small incision and empty the joint cavity, irrigate with salt solution, and thus you will hasten the patient's recovery and at the same time do away with the possibility of sepsis. You will also avoid, by this simple

surgical procedure, most of the consequences of intra-articular collections, such as muscular atrophy, stiffness in the joint and the development of adhesions.

After the joint cavity has been cleaned out, the small incision in the capsule is closed with catgut sutures, the entire operation having been as aseptically carried out as an abdominal operation, otherwise you will meet with disaster. A compressive dressing is applied which should not be removed for five or six days, if all goes well, and the limb immobilized in a wire gutter. At the end of a week recovery will be far advanced and the patient will have retained the totality of movements in the joint.

When there is pyrexia it is ordinarily the result of an infected hæmatoma and the immediate prognosis is more serious, while expectant treatment would be a very grave mistake.

Arthrotomy is indicated and should be undertaken without the least delay. An incision should be made on each side of the patella and a rubber drain inserted into each. The tubes are retained in place by a silkworm-gut suture uniting them to the skin incision. After washing out the joint contents with sterile salt solution, the limb is immobilized in a posterior plaster case, and the limb elevated. All pain ceases immediately and the joint is placed in absolute rest.

The joint is irrigated once or twice daily with sterile salt solution or with some *very mild* antiseptic solution if preferred, after which it is good practice to spray the joint cavity with ether. But as soon as there is apyrexia and the wound has taken on a nice red look, irrigation is to be stopped and aseptic dry dressings applied every two or three days according to the amount of discharge, and the drains are removed. Intra-articular blood collections can be safely opened when aseptically done even in ambulances at the front. Classic arthrotomy for pyarthroses of the knee-joint, without the presence of the projectile and without damage to bone, is useful only as far as evacuation of the pus is concerned and immobilization of the joint in a plaster case is the principal factor in the cure, since it acts by overcoming the inflammation. I would also point out that in suppurating hæmarthroses the inflammatory reaction of the synovia is relatively slight and in reality represents a mild type of suppurating synovitis. When a suppurating arthritis, such as above described, does not progress satisfactorily, usually because the operation has been done too late, synovectomy has been recommended, but I should advise you not to dally with this operation but to resort without delay to subperiosteal resection of the joint.

Penetrating wounds of the knee with the projectile remaining in the joint. First, as to the symptomatology of foreign bodies in the articulation when infection is absent, the patient apyretic and the knee-joint neither red nor markedly swollen, in other words, when there is no notable inflammatory reaction in the joint containing a bullet or bits of projectile. One is always dealing with a patient who is suffering with a joint immobilized in extension or in slight flexion and containing some fluid. The subjective

symptom pain and the more or less evident objective symptom of an intra-articular fluid collection are constant. The most characteristic pain is that due to the wedging in of the projectile between the two bony planes. It may be continued and become intolerable when any movement is given to the joint. If the projectile is located under the edge of the patella the pressure of the finger over the projectile will cause a very localized intense pain. Localized pain on pressure has also been encountered when the projectile was interposed between the tibia and femoral condyles. It is a most constant symptom, very sharp and localized, increased by external pressure of the area of the projectile and by movements imparted to the joint. The intra-articular fluid collection is rarely absent, but the joint is enlarged, not because of œdema or lymphatic infiltration, but because there is a trauma of the component elements of the articulation and the fluid may be simply serous, occasionally seropurulent. This fluid, like all traumatic intra-articular collections, finally disappears under proper treatment or else it becomes secondarily infected. The diagnosis of the presence of a projectile in the joint is an easy matter when with the two above-mentioned symptoms there is a single aperture in the integuments and then a radiographic examination will locate the site of the foreign body. This should be done before any operation is undertaken.

Now, let us suppose that the patient is brought in with an enlarged knee presenting a single aperture and there is pyrexia. Let me say at once that an extra-articular foreign body may very well give rise to this clinical picture from the traumatism alone and cause a considerable intra-articular fluid collection, so that it would be a gross mistake to resort to arthrotomy at once before making a radiographic examination, since the removal of the projectile situated outside of the joint capsule is quite enough to cause all symptoms to subside and bring about a rapid recovery.

It is equally obvious that a joint may be opened and yet the projectile not be discovered, and it is likewise clear that the prognosis will be very different according to whether or not the projectile has been found and removed. Besides revealing the site of the projectile, radiography will show the bone lesions if any exist and, therefore, is a guide of the greatest importance as to the surgeon's conduct of the case.

I will first consider injuries of the knee-joint in which the projectile is free in the articular cavity. Clinically, you will find the knee enlarged, frequently larger and more inflamed than when there are two apertures. In the cases under consideration there is only the entrance wound, which will differ essentially in aspect according to the nature of the projectile. A rifle bullet, unless it ricochets, nearly always produces a punctiform entrance aperture, while a shrapnel ball gives rise to a somewhat larger entrance wound, but relatively circular in outline, while bits of bursting shell produce a stellate entrance wound which varies in dimensions according to the size of the projectile.

Since the nature of the foreign body plays an important part in penetrating wounds of the knee, it may perhaps be well to make a distinction

according to whether the projectile is a bullet, a shrapnel ball or a piece of bursting shell. Although rifle bullets have been, and to some extent still are, looked upon as aseptic foreign bodies, on account of their penetrating velocity, and although they do not usually carry any bits of clothing into the wound and occasionally appear to be fairly well tolerated by the joint, it is none the less true that their removal should be undertaken without delay. Shrapnel shot, which is larger than the small-bore bullet, is much less aseptic than the latter and always carries in bits of clothing along with it as it is most always deformed. For this reason, too, it produces contuse lesions of the soft capsular structures, and, therefore, as it is almost certain to set up infection in the joint, it should be extracted as soon as possible after the receipt of the injury. Bits of shell, on account of their sharp irregular edges, often from their size as well, the bits of clothing which they invariably carry into the wound and the severe lesions to the soft capsular structures that they produce, give rise to extremely serious infections which develop with great rapidity. Therefore, their early removal from the joint is imperative.

The foreign body having been exactly located by radiography or, more simply still, by a precise radioscopy, you will proceed to remove it. At one finger's breadth outside of and behind the cutaneous elevation at the external border of the patella and parallel to it, an incision is made whose upper angle reaches to within three fingers' breadth above a plane passing through the base of the patella. Below the incision extends to the level of the tuberosity of the tibia by giving it a slightly curved direction with its concavity looking slightly upward and inward. The skin having been incised you will have exposed the fleshy body of the vastus externus, at the upper part of the incision, while at its middle opposite the external border of the patella, is the outer wing of this bone, and, lastly, at the lower part one sees the external border of the ligamentum patellæ. Following the direction of the skin incision the capsule is opened beside the patella and the joint cavity is entered. The borders of the opening in the capsule are held with hæmostats and the incision is extended upward to the apex of the subquadricipital cul-de-sac, but in order to reach this point some of the fibres of the vastus externus must be cut. The capsular incision is next carried downward and thus the joint is completely opened by suppressing the upper and lower capsular culs-de-sac and an unobstructed view may be had of the articular ends. To facilitate the exploration of the bones of the joint, it is an easy matter to make an inward dislocation of the patella while the entire extent of the bone surfaces may be seen by making a latero-internal flexion of the leg. In some cases the projectile may be removed if it is free in the joint cavity, while if it is lodged in the bone it can be removed under the control of the sight. This technic does not mutilate the structures surrounding the patella, and later on, if considered feasible, resection of the bones can be done without resorting to complementary incisions. In other words, an arthrotomy carried as described can, in certain cases, be the first step in a resection of the joint. After

removal of the projectile the joint is immobilized, as already described, in a posterior plaster case.

Let us now suppose that the projectile is lodged in the bone without fracture or fissure having taken place. This condition is sometimes met with. In these circumstances there is little difference in the operative technic from that just described, but when the foreign body is a shrapnel ball or a piece of exploded shell, the joint is usually, if not always, infected, and then I advise making the U-shaped incision in order to freely expose and drain the joint if resection is not deemed necessary.

Penetrating wounds of the knee with bone lesions, a condition that is the most frequent in the present war. These lesions are very serious on account of their evolution, and this fact has led many surgeons to resort to amputation at once, a practice which I most strongly condemn. Allow me to impress upon you that the bone lesions represent the only factor of gravity in these injuries. This notion is fundamental from the standpoint of treatment, and, as I shall endeavor to show, it is absolutely necessary for every surgeon to know, given the frequency of this class of penetrating wounds of the knee by projectiles of war. They may probably represent about 33 per cent. of wounds of the knee-joint treated at the front. This proportion may be reversed in the case of base hospitals. What is essential is not to underestimate the frequency of fractures of the epiphyses and the terrible consequences arising therefrom when the condition is overlooked. Indirect fractures are the result of intra-articular fissuring starting from the focus of fracture seated either in the tibial diaphysis or that of the femur. Direct fractures follow the traumatic action of the projectile, be it a bullet, shrapnel or a piece of bursting shell. These vulnerable agents are quite susceptible of giving rise to identical bone lesions regardless of their varied shapes and different velocities.

The bone involved may be the tibia, which is most exceptional, frequently the patella and still more frequently the lower end of the femur. In the latter case only one condyle may be involved, sometimes the lower end is smashed to bits so that it represents the true type of fracture with multiple fragments.

The projectile will be found either free in the joint cavity or embedded in the bone surface or medullary cavity.

Besides these principal lesions of the epiphyses, the occurrence of fissures in the diaphysis of the corresponding epiphyses must not be overlooked. The notion of these epiphyso-diaphysary fissures is of considerable importance in practice, as it gives the reason of failure in cases of delayed resection and explains the necessity of amputation. These fissures are the factors of osteomyelitis, an important cause for amputation in injuries of the knee-joint.

The surgeon will also have to deal in some severe injuries of the knee with lesions of the surrounding soft structures. There is frequently a formidable disproportion between the bone lesions and the outer aspect of the knee. A

projectile producing a small entrance aperture may work havoc in the bones of the joint and it is only by radiography that the real extent of the damage to the joint will be ascertained. Occasionally this examination will be insufficient, as it only reveals bone lesions of lesser importance. It is a demonstrated fact that no relation exists between the evolution and the degree of fracture and it is well known that serious complications can arise quite as well in cases where only one condyle is destroyed as when the entire epiphysis of the femur is involved. For this reason it is essential to exactly define the extent of the lesions, and this can only be obtained by taking radiographs in two different planes.

The clinical evolution of penetrating wounds of the knee-joint when only treated by arthrotomy is somewhat as follows: During the first four or five days following the interference, there is an exclusively local reaction in the joint, the temperature ranging between 38° and 39° C. or even higher. The important fact to be noted, however, is that although there will probably be *a decrease in the amount of suppuration, on the other hand you will discover that there is an increase in the size of the lower end of the femur and upper end of the tibia; the popliteal space becomes tumefied, an œdema, which progressively extends upward to the thigh or downward to the leg, appears, the inguinal lymph-nodes are greatly enlarged and the general condition of the patient becomes bad, assuming a typhoid state.*

Now, regardless of the absolute immobilization and complete rest of the joint, the patient will nevertheless complain of pain in the bones, spontaneous in character and which is characteristic of osteomyelitis. Such is the usual outcome of arthrotomy pure and simple done in cases of penetrating wounds of the knee-joint with bone lesions. Consequently, it is clear that arthrotomy is a useless operation in these circumstances, and, if the patient escapes with his life after amputation has been done, he does so with the loss of his limb.

The proper treatment of these cases when seen in time, that is to say, within the first thirty-six hours, perhaps two days, following the receipt of the injury, as is the case in the immense majority of them, is typical subperiosteal resection if the amount of damage done is not so considerable as to require more than the excision of 10 centimetres, as otherwise the resulting shortening would leave a useless limb. Of course, when the damage to the bone is too considerable, likewise that of the surrounding soft structures, with lesions of the popliteal vessels, amputation is the only recourse left to save the patient, and in order to be as economical as possible, *always perform circular amputation as low down on the thigh as possible and never suture the stump*. The further development of infection will thus be avoided.

What is the real value of arthrotomy in penetrating wounds of the knee-joint with bone lesions? In reply to this question I say without the slightest hesitation that it is devoid of any, and, whether done directly after the injury has been received or when done some time after, *arthrotomy will not prevent the nefarious evolution of infection and osteomyelitis, and in cases in which*

this operation has given good results the lesions were confined to the synovia and no damage done to the articular surfaces.

Those surgeons who start with the erroneous idea that in order to cure a knee-joint in which the epiphyses are injured by the missile, it is enough to create free drainage of the pus, base their mistaken notion upon an inexact anatomical idea, namely, that any retention which may arise in the synovial cavity of the joint at its posterior aspect may be considerable, on account of the recumbent position of the patient; starting likewise from the erroneous pathologic standpoint that the posterior swelling is due to an intra-articular collection in retention, the consequence of this threefold erroneous interpretation of these injuries is that certain surgeons have devised arthrotomies with multiple or posterior incisions, all to no purpose, as can readily be surmised.

I am convinced that in this group of penetrating wounds of the knee-joint arthrotomy, no matter what technic may be followed, despite the most perfect immobilization and after-treatment, will never, under any conditions, cure the bone lesions. *Arthrotomy in these cases means an early amputation at the thigh!*

The only proper and, I may add, successful treatment of penetrating wounds of the knee with lesions of the bones is typical resection almost always, occasionally atypical. A comparison of the results obtained by other methods, a correct knowledge of the pathology and clinical evolution of these lesions, clearly reveal the value of this operation. What any surgeon of experience should know of the structure of the femoral and tibial epiphyses is in itself a sufficient explanation of the teachings I maintain. We know that the femoral and tibial epiphyses, as well as the patella, are constructed, from the architectural viewpoint, by osseous layers which are dovetailed together in both the transversal and vertical directions in order to form a spongy, areolar tissue. This spongy tissue is highly receptive to infection of any sort and the occurrence of osteosarcoma and tuberculous osteitis developing in the epiphyses of the femur is frequent. Therefore, one can readily understand how bacteria brought into the bone on the missile itself, but above all on the bits of clothing carried into the wound, find a particularly favorable soil for their rapid development, and those who are familiar with the extreme virulence of the infective agents in the surgery of warfare are fully aware of the particularly distinctive evolution of these bacteria in a soil well disposed for their reception.

On the other hand, in cases of fracture where there is little, if any, displacement of the fragment or fragments, infection will nevertheless travel by way of the anatomical communications uniting the spongy tissue of the epiphysis with that of the diaphysis and from here invades the medullary canal, and the outcome is an acute osteomyelitis of severe grade. When the epiphysis is broken into numerous fragments these become infected almost from the time of the receipt of the injury, as they are mostly cut off from their blood supply, and represent just so many septic foreign bodies Therefore common sense dictates that these must be removed and that subperiosteal

resection is the only rational treatment in the class of injury under consideration.

To derive the greatest amount of good from subperiosteal resection of the knee-joint, the time at which it is undertaken is of capital moment.

If the operation is resorted to some time after the receipt of the injury, between ten and twenty days, or if the operation is done following a primary arthrotomy which, unfortunately, is not uncommonly the case, it may be termed a late resection.

Defined as above, late resection gives very bad results and is bound to give rise to disappointment and discredit this otherwise orthopædic and life-saving operation, which should be resorted to early during the first three, perhaps four, days following the receipt of the injury. Of course, it goes without saying that the anatomic diagnosis has first been made by means of radiography. The details of subperiosteal resection of the knee-joint will have to be reserved for later discussion.

FIG. 1.

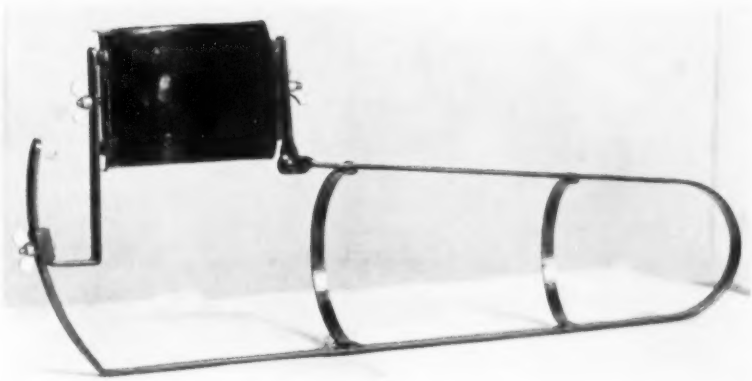


FIG. 2.

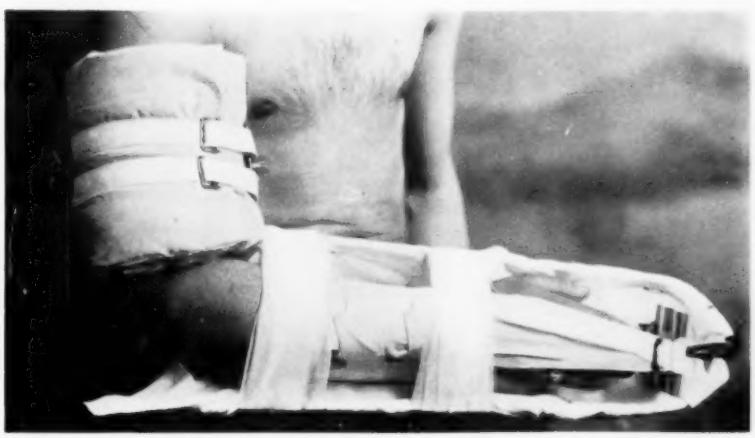


FIG. 3.

APPARATUS FOR THE TREATMENT OF COMPOUND FRACTURES OF THE FOREARM

By H. T. Buckner, M.D.
of Seattle, Wash.

I wish to present a new apparatus for the treatment of compound fractures of the forearm and compound fractures in and about the elbow joint.

The apparatus consists of two parts: A metal cuff that is well padded and strapped around the humerus and a metal frame that holds the forearm. The frame is made longer than the forearm in order that extension straps may be fastened to the forearm, and to the straps is fastened some rubber—that is, fastened to the cross-bar of the frame, thus permitting extension to be made upon the forearm if desired.

A piece of canton flannel or muslin may be folded over the longitudinal bars and pinned, making a soft hammock for the arm to rest in. If necessary for a little firmer support, a well-padded splint may be put in the hammock beneath the forearm.

The frame is made adjustable so that you can move the elbow a little when desired, as well as be able to dress the arm in the desired amount of flexion.

The frame is open, so the wounds are easily reached, and any method of sterilization of the wound can be used or carried out.

By turning the cuff over that fits around the humerus and by turning over the cross-bars, you can use it on the opposite side, thus making it suitable for either right or left arm.

The splint is light and can be made either of aluminum or iron.

The splint is an ambulatory one, and the patient can be up and around without retarding his recovery.

A NEW INCISION FOR EXPOSURE OF THE LOWER ABDOMEN AND PELVIS

By John W. Churchman, M.D.

of New Haven, Conn.

Professor of Surgery, Yale University

The incision here described was devised on account of my dissatisfaction with the exposure given by other incisions in operating on the rectum and on the pelvic ureter. It was first employed in an exploration of the abdomen for malignant disease of the rectum in which it was expected that a combined excision would have to be done and a good exposure of the deep portion of the pelvis would be needed. The rectal growth proved to be a melanotic sarcoma [1] and as there were multiple metastases in the liver no resection was made. The exposure of the left side of the pelvis was so excellent, however, and so superior to that obtained by the ordinary incisions —and this with little or no retraction—that I now regard it as the incision of choice when wide exposure in this part of the abdomen is necessary. No one who has operated on the common duct through a longitudinal incision and has compared the exposure thus obtained with that provided by a hockey-stick incision in which the m. rectus abdominis is divided transversely, can doubt the importance of good exposure; for with the latter incision a common duct operation can be properly done, while with the former the surgeon—working in the depths and requiring the constant tug of strong retraction—can do justice neither to himself nor to his patient.

In a similar way the incision here described gives excellent exposure of the whole lower abdomen and pelvis. The incision may be made on one side only (Plates I and II). Or, when wide exposure of the whole pelvis is needed (as, for example, in the case of large impacted myomata), the lateral oblique incision may be made on both sides (Plates III and IV); when this is done, the edges of the incision fall apart and little retraction is needed for the roomiest possible exposure.

The closure of the incision is by the fascial overlap method [2] and the abdominal wall is therefore left stronger than before operation. As the upper arm of the incision is made by splitting the m. obliquus externus in the direction of its fibres, the incision is well adapted for operations on the left colon and rectum, not only on account of the excellent exposure obtained, but also because of the fact that the ideal conditions are present for a colostomy, the muscle being closed about the bowel much as is done in a colostomy through a MacBurney incision.

The advantages of this incision over the Pfannenstiel are obvious. In

[1] This I have reported elsewhere.

[2] Every abdominal incision should be closed by the fascial overlap method. particularly every midline incision; the occurrence of post-operative hernia in midline wounds is inexcusable and will be absolutely prevented if the fascia is overlapped.

PLATE I

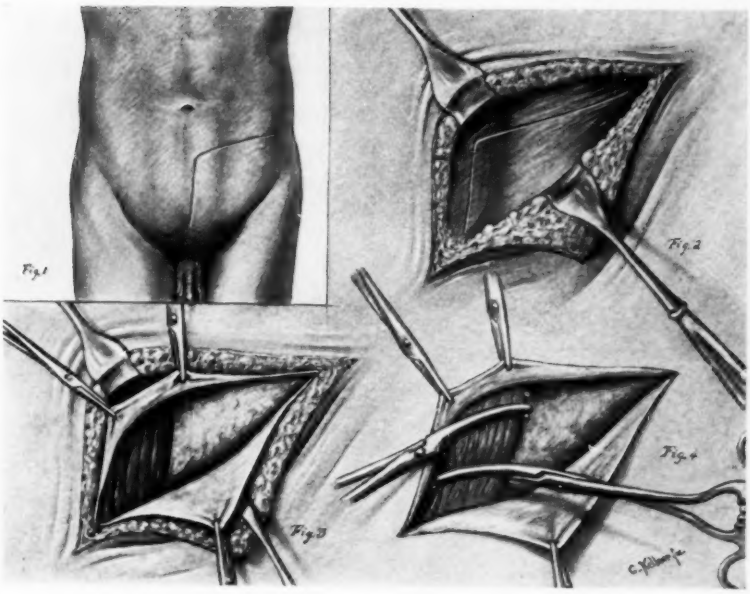


FIG. 1.—Skin incision.
FIG. 2.—Fascial incision (the horizontal arm should run exactly in the direction of the muscular fibres and not at slight variance with that direction, as shown in the illustration).
FIG. 3.—Fascial incision; rectus exposed, after reflection of fascial flaps.
FIG. 4.—Rectus grasped by clamps.

PLATE II

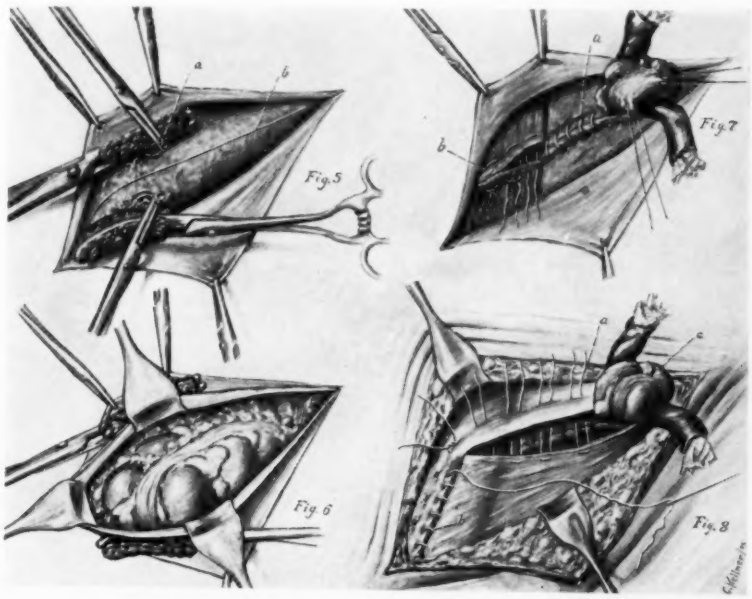
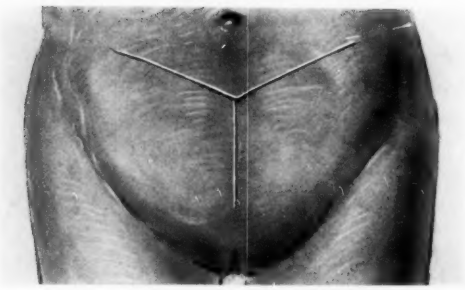


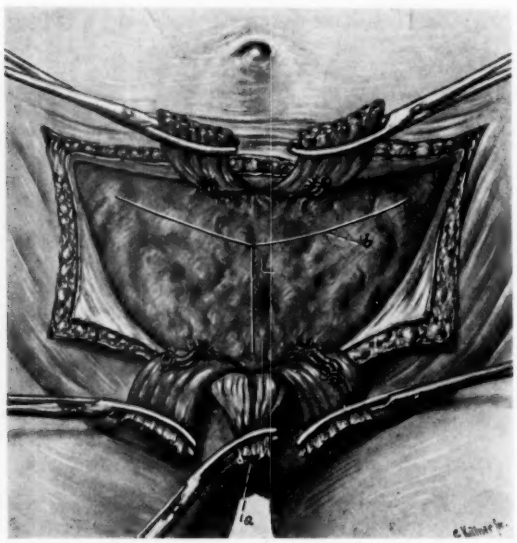
FIG. 5.—Rectus divided: *a*, epigastric vessels ligated; *b*, incision in transversalis fascia and peritoneum.
FIG. 6.—Exposure of peritoneal cavity.
FIG. 7.—Beginning of closure: *a*, continuous stitch in peritoneum and transversalis fascia; *b*, mattress stitches in rectus.
FIG. 8.—Closure continued: *a*, overlapping of anterior sheath and external oblique fascia by mattress sutures, and (*b*) suture of free edge; *c*, bowel left out for colostomy.

PLATE III



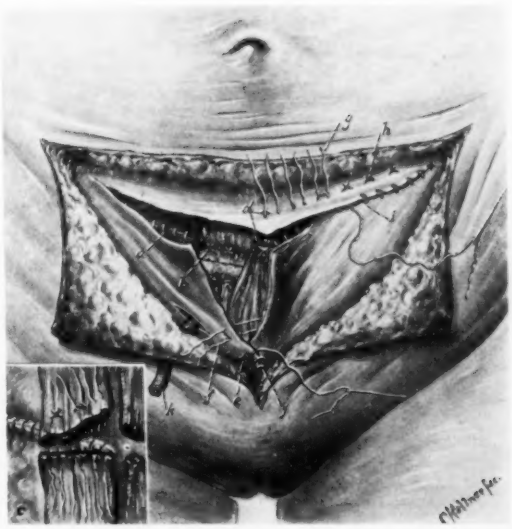
Bilateral incision in skin.

PLATE IV



Both recti and pyramidalis divided; epigastric vessels ligated; Y-shaped incision in transversalis fascia and peritoneum.

PLATE V



Closure of bilateral incision: *a*, running stitch in peritoneum; *b*, divided recti tacked to underlying fascia by mattress sutures (detail shown in *c*); *d*, pyramidalis tacked to under surface anterior sheath; *e* and *f*, overlapping by mattress sutures of anterior sheath and (*g* and *h*) external oblique fascia; *j*, suturing of free edge of anterior sheath and (*i*) external oblique fascia; *k*, drain.

the Pfannenstiel incision the abdominal wall is divided transversely *at one level;* my incision begins at the symphysis pubis and ends at the level of the anterior superior spine (or higher if one wishes). The recti muscles are then divided transversely. Both the lower and upper portions of the pelvis are therefore exposed at the same time: a point of great importance in operations on the rectum and on the ureter, or in extensive transperitoneal resections of the bladder.

The technic of the unilateral incision is well shown in Plates I and II, and needs only a few words of description.

1. *Skin incision* (Plate I, Fig. 1) begins at the symphysis pubis, runs in the mid-line upward for about two inches, then diagonally upward and outward toward the anterior superior spine. The point at which the longitudinal incision becomes oblique may be higher or lower, according as the chief exposure desired is the upper or lower part of the pelvis.

2. *Fascial incision* (Plate I, Figs. 2 and 3) repeats the direction of the skin incision, dividing the rectus sheath longitudinally, then crossing obliquely the anterior sheath and dividing the fascia of m. obliquus externus in the direction of its fibres[3] and as high toward the anterior superior spine as desired. It is of great importance, in operating on the bladder, that the anterior sheath of the rectus be divided down to the bone at the symphysis pubis.

3. Muscle incision (Plate I, Figs. 3 and 4; Plate II, Fig. 5).—The rectus muscle, thus exposed, is freed and divided between clamps. Care is taken to push back the epigastric vessels from the posterior surface of the muscle, clamp, divide and ligate them separately (Plate II, Fig. 5, *a*).

4. The fascia of the m. transversalis and m. obliquus internus and the peritoneum are divided by an incision which repeats the direction of the skin incision (Plate II, Fig. 5, *b*).

5. The exposure thus obtained, practically without retraction, is shown in Plate II, Fig. 6.

Closure: a. The peritoneum (with transversalis and internal oblique fascia) is sutured by a running stitch (Plate II, Fig. 7, *a*).

b. Muscle.—The divided rectus muscle may be approximated by mattress sutures (Plate II, Fig. 7, *b*). No effort at *accurate* approximation should be made nor should the stitches be drawn as tightly as shown in the illustration. The stitches do not hold well if the muscles—as is likely to be the case—are at all flabby. When there is any difficulty about bringing the cut ends together, they may be tacked to the underlying fascia as shown in Plate V, *b* and *c;* in this way the ends may be easily approximated. A good approximation of the rectus muscle is not necessary; the strength of the abdominal wall depends on the careful closure of the fascia and that is done on the principle which governs the radical cure of hernia.

c. The anterior sheath of the rectus and fascia of the m. obliquus externus (Plate II, Fig. 8) are closed by the overlapping method used in the radical cure of hernia, a flat overlap being obtained by one layer of

[3] The incision should be made *absolutely* in the direction of the fibres and not (as shown in the illustration) slightly at variance with that direction.

mattress sutures (Plate II, Fig. 8, *a*), and a second layer which tacks down the free edge (Plate II, Fig. 8, *b*). In the illustration space has been left for a colostomy (Plate II, Fig. 8, *c*) to illustrate that this may readily be done in cases where a colostomy is to be performed.

d. The skin is closed by a running stitch.

If exposure of the whole pelvis, rather than of only one side, is desired the incision is made on the principles just described, but the oblique arms pass to *both* sides from the mid-line as is shown in Plates III, IV, and V. After division of the anterior sheath and fascia of the m. obliquus externus and of the rectus muscle on both sides, the edges of the incision fall apart. The incision in posterior sheath and peritoneum repeats the direction of the skin incision (Plate IV, *b*). A wide semilunar opening is then present in the abdominal wall, and the whole lower abdomen and pelvis are exposed practically without retraction (Plate IV). In this patient a well developed m. pyramidalis was present and is shown divided across (Plate IV, *a*). I have been struck by the unusually easy convalescence, so far as abdominal pain is concerned, of patients in whom this incision has been used and it has occurred to me that the slight amount of retraction needed may account for their comfort.

The closure, when the incision is made on both sides, is identical in principle with that done when a unilateral incision is made. The steps are shown in Plate V. The peritoneum has been closed with a running stitch (Plate V, *a*), the recti tacked to the underlying fascia with mattress stitches (Plate V, *b* and *c*), the m. pyramidalis has been tacked to the under surface of the anterior sheath of the rectus (Plate V, *d*), mattress stitches overlapping the anterior sheath (Plate V, *e* and *f*) and the fascia of the external oblique (Plate V, *g* and *h*) have been placed. A running stitch is tacking down the free edge of external oblique fascia (Plate V, *i*) and the anterior sheath of the rectus (Plate V, *j*). It is probably a wise precaution, and in no way complicates matters, to insert a small drain for serum through skin and sheath down to the intermuscular space (Plate V, *k*); this I always do in operating for umbilical hernia, in which a closure is made similar in principle to the one here described.

The fear of dividing the rectus muscle transversely which haunted all surgeons for years, and still haunts some, is it seems to me entirely unwarranted. It is true that it is impossible accurately to approximate the edges of the muscle so divided; but the union of the cut edges with fibrous tissue provides a perfectly good functional result. Nor is the fear that injury of the nerve supply of the muscle will increase the liability to hernia justified. The strong closure of the abdominal wall is a question of structure and not of function; if the fascia be properly closed, hernia will not occur no matter what the condition of the muscle. I have often deliberately divided (in inguinal hernia done under local anæsthesia) the ilio-hypogastric and ilio-inguinal nerves without jeopardizing the result; and to explain the recurrence of a hernia by nerve division is to overlook the real cause which was faulty closure.

ABDOMINAL WOUND TECHNIC

By John O'Conor, M.D.

of Buenos Aires

SENIOR MEDICAL OFFICER OF THE BRITISH HOSPITAL AT BUENOS AIRES

I ASSUME that my experience is not unique when I state, that, although over ninety per cent. of wounds which are aseptic prior to operation remain so afterwards, there is still quite a percentage in which we find that the wound which appears perfect on the sixth day is converted into a leaking puddle of blood and peptonizing fat by the twelfth. In other words, a modern aseptic wound does not necessarily imply a good physiological one.

The object of this communication is to endeavor to draw these two factors more into line. And it is my belief that the solution of the problem can be found in our paying more acute attention to hæmostatic details and to the elimination of dead spaces.

The vital essential in the treatment of any wound is hæmostasis, and I have no hesitation in stating that the surgeon who ties most bleeding vessels gets the best results, and as my teacher, the late Sir Charles Ball, used to say "sleeps better the night after." Prompt and permanent stemming of the crimson tide is our most valuable asset, it makes surgery possible, it favors repair, it obviates sepsis, it prevents shock, and it saves life.

The details which I am about to mention may appear very trivial, but when added together may help to encourage method on which operative efficiency largely depends.

In most operations on the abdominal wall, inguinal hernia in particular, one has frequently to forceps ten or twelve vessels, half of which may be seized accurately, the other half have to be caught up with some surrounding tissue, yet the method of ligation is absolutely different in each variety. In the former the forceps must not be unlocked until the knot is tied, and ends of ligature cut away, otherwise slips and blanks ensue.

In the latter, bleeding will continue if the forceps are not unlocked before the knot is completed, as the interposition of the forceps head and extra tissue, in mass, acts as a buffer, and prevents the final snap of the ligature which is necessary for the effective constriction of the bleeding vessel. And it may be well to remember that gentle torsion is, at times, a useful preliminary to prepare the way for the ligature of small vessels, difficult to isolate, in connective tissue. Again, it is extraordinary how few understand the simple art of swabbing a bleeding wound, nine assistants out of ten, when told to "dry," will apply the mop with a jerky horizontal wipe instead of with a steady vertical dab, the result being, that ligatures are frequently brushed off as quickly as they are applied. There is another matter which demands serious attention—the planning of our lines of incision so as to avoid tapping important vessels during the course of an

operation; injuries with the knife can be easily controlled in daylight, but a puncture with a needle often proves to be the Devil in the dark. And I do not know of any operation in which there is greater likelihood of meeting with the latter than in the present fashionable vertical lateral incision for removal of the appendix, and I can personally bear witness to the facility with which a deep epigastric vessel may be speared when suturing the wound. *En passant,* I have for this reason recently reverted to the McBurney incision, when same is pathologically feasible. Also, it is well to bear in mind that hemorrhage which spontaneously ceases after exposure to air, or during the course of the operation, may be a very elusive quantity, in that the temporary fall of blood-pressure frequently induces a false hæmostasis in small cut vessels, but afterwards, when the patient is warmed up in bed, and reaction takes place, there is every likelihood that some bleeding will recur, particularly as the unligatured vessels are constantly stimulated by the involuntary jactations of a semiconscious patient.

May I add that ligation is the only method of stasis in which I have any confidence, and its value may be considerably enhanced by a good closure suture which keeps the respective wound structures in firm apposition.

The success of the technic of wounds is so absolutely dependent on the preliminary preparation of the patient's skin that it would be puerile to omit mention of the latter when describing the principal details of the former. For many years, my rule has been, on the evening prior to operation, to have the part shaved, scrubbed with nail-brush, soap, and hot water, well washed with alcohol mercurial lotion (hyd. perch. 1, acid. tart. 5, water 200, alcohol 800), and then covered with sterilized lint soaked in mercurial lotion (hydr. perch. 1, acid. tart. 5, water 2000), sterilized wool and bandage. This dressing is not removed until the patient reaches the operating table on the following day, when a final washing with alcohol mercurial lotion is done, before the field is isolated with dry sterilized towels. Some few years ago we were all suddenly overcome with the comparative simplicity and efficiency of the iodine method, and after its employment in hundreds of cases, I have much to say in its favor, particularly for accident and emergency work where rapidity is a necessity. Also, it is beyond all question that in operations on the suspect nether regions, tincture of iodine acts extraordinarily well. But, like everything else in life, it must have some compensatory defect, and I must acknowledge that I have suffered more with serious intestinal adhesions during the past three years of iodine treatment than in the previous three and twenty with the above-mentioned mercurial one. This has been particularly accentuated in cases in which some extrusion of bowel was an operative necessity, such as posterior gastro-enterostomy, ileocolostomy, etc. Consequently, I have to endorse what has been recently reported elsewhere—iodine is a dangerous peritoneal irritant. During the past few months I have gone back to the old method for ordinary abdominal work.

Irrespective of the particular method employed in disinfecting the skin,

I think that it is essential to adopt some plan for the complete isolation of skin and exposed layers of parietal wall from the operative field. This I find can be easily accomplished by utilizing Mr. Marmaduke Shields' method of holding the abdominal wall together in prolonged operations. Years ago he recommended that a few through-and-through silk sutures should be passed through each parietal wall before commencing internal manipulation, so as to prevent subsequent separation of the parietal strata, and so reduce the chances of infection and the probability of defective repair ensuing in structures which are often, unnecessarily, mutilated during a protracted operation. He, at the same time, suggested that the ends of such sutures, if grasped in forceps, provided very convenient retractors. These excellent practical suggstions may be amplified by placing a small towel of fine texture, with a slit in centre (corresponding to length of wound) around area of incision, two through-and-through strong silk sutures are passed, on each side respectively, embracing peritoneum, muscular wall, skin and towel (passing on each side about one inch external to the edge of slit in latter). When these sutures are tied, the included fringe of towel drops down to level of peritoneum, and forms a fixed curtain which completely excludes the exposed surface of the parietal wound, and the large superficial portion of towel completely occludes the underlying skin in the operative zone.

Thus the possibility of peritoneal irritation, from contact with skin, is eliminated, infection of parietal wound from intestinal leakage is avoided, and the parietal layers being held in position obviates fumbling about, at the conclusion of the operation, in search of a retracted edge of peritoneum or rectus sheath.

It is unnecessary to add that when the intraperitoneal work is finished, the shield stitches and towel are removed, and closure is effected by continuous catgut tier sutures.

The Closure of Wound.—There are some structures in the abdominal wall which do not always receive the amount of suturing attention which they deserve, viz.: the posterior lamina of rectus sheath (in upper mesial segment), the transversalis fascia generally, and the subcutaneous fatty layer (which, by the way, contains most of the wounded blood-vessels) in particular. Commencing with the continuous suture of peritoneum, I recommend the practice of catching up the corresponding edge of posterior lamina, or transversalis fascia, in each stitch, in order to obtain some point *d'appui* for the firm closure of peritoneum, which is often very fragile and holes readily form, which, if undetected or neglected, afford an ideal lie for an omental or intestinal adhesion and an excellent tee for a subsequent ventral protrusion. Moreover, the cultivation of the habit prevents one forgetting, at the fatigue stage of the operation, the anatomical existence of a posterior rectus sheath or a transversalis fascia; both in their respective sphere are useful, indeed necessary, adjuncts to the normal restoration of the parts.

The Subcutaneous Layer.—Accurate approximation, by suture, of the subcutaneous fatty tissue is the best preventive against the formation of

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The Subcutaneous Layer.—Accurate approximation, by suture, of the subcutaneous fatty tissue is the best preventive against the formation of

a dead space in which stagnant blood is most likely to accumulate—blood which very soon becomes converted into disintegrating toxic fibrinous material, which frequently serves as an ideal medium for the cultivation of pathogenic germs, which always protracts convalescence, which attenuates the underlying line of tier suture and so favors the formation of subsequent ventral hernia, which affords the pabulum for that most annoying and compromising circulatory condition, femoral phlebitis, and which occasionally allows a deadly missile, a flat globule or clot, to gain entrance to an open vein, and find its billet in the pulmonary artery. I have met them all—every thing will happen to a surgeon if he will only live long enough.

It may be alleged that if the tier method of suture were abandoned, and we reverted to the old " through-and-through," dead spaces would be avoided. This is, to a certain extent, correct, but it possesses some distinct drawbacks. To be effective it must possess some tension, which is almost impossible to graduate, and which, very often, proves detrimental to the vitality of the structures encompassed in its grasp. And its insertion entails the employment of a large needle, which is driven out of hæmostatic range, oftentimes wounding deep-seated hidden vessels, with resulting deep-seated hidden hæmatomata, which may be even more dangerous (phlebitis and embolism) than the existence of a subcutaneous swamp, which is readily exposed. It, moreover, seriously compromises the future function of the muscles and nerves within its ambient. Notwithstanding such disadvantages, I consider it to be the lesser of evils, in septic cases, as it would be fatuous to bury continuous layers of any suture in the parietal wall in the presence of virulent infection. However, in such instances, it is my custom to employ as few sutures as possible, with the minimum of tension, always in association with large tubes, which serve a double purpose—drain both abdomen and abdominal wall.

I have oftentimes employed a combination of both, continuous catgut suture of peritoneum and rectus sheaths, and interrupted silkworm-gut sutures to close, in mass, the subcutaneous layer and skin. I have seen many excellent results follow this practice, but it has, like the above-mentioned one, to be frequently supplemented with some superficial sutures so as to accurately approximate the edges of skin wound. I find that the skin, subcutaneous wall and subcutaneous floor (ant. lamina of rectus sheath or external oblique as the site may be) are, respectively, more effectively and expeditiously united by employing a form of continuous catgut suture which we term the Gallo stitch (Fig. 1). And in order to exclude ambiguity, it is only necessary to remember that the needle, in transit through above structures, always passes away from the operator, viz.: from proximal to distal side of wound. Commencing at one angle of the wound, a needle, with a long strand of strong catgut attached, is passed solely through skin and close (2 mm.) to edge of same on each side, and suture tied. The needle is then passed through skin (proximal side) at a point about 13 mm. from the edge of wound, traverses the whole depth of proximal wall, then catches

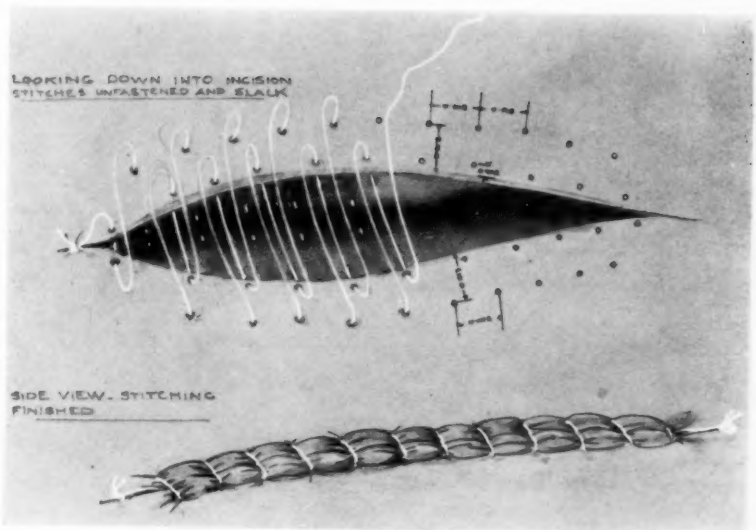

FIG. 1.—The "Gallo" stitch for closing abdominal wounds.

up a few fibres in centre of floor, reënters on this level and passes from within outward through the distal wall at a corresponding point on skin 13 mm. from distal edge. The needle is next carried back across wound, and enters skin 2 mm. from proximal edge, passes again over wound and is made to emerge through skin 2 mm. from distal margin. In this manner continuous alternate deep and superficial sutures are applied until the whole wound is closed. Then the efficacy of this suture, for approximation purposes, is tested by folding up a bibule, and rolling same, with firm pressure, from one end of wound to the other. If blood escapes in the last roll the suture is defective—so far I have not seen an instance of it. I may mention that I have frequently applied this test for needle bleeding and ligature slipping hemorrhage to the other forms of continuous sutures depicted in text-books, and have invariably found positive evidence of this insidious, invisible, and, oftentimes, pernicious type of hemorrhage following the closure of wounds which appeared perfectly dry before the introduction of sutures.

Some years ago I tried a similar method of suture, using silk, but found that the resulting tension was inimical to aseptic union. The extra resiliency and gradual absorption of catgut probably explains the difference in results. In dozens of cases in which this suture has been employed there has not been a single instance of subsequent skin necrosis, sepsis, or subcutaneous collection of serum, and all have healed by physiological first intention. There is, on insertion, some slight puckering (never infolding) of skin along suture line, which disappears in a few days. And the suture is removed by the natural process of absorption in the third week. This suture may be briefly described as a continuous one, approximating alternately (1) the mere edges of skin, and (2) the skin, subcutaneous layer, plus a chip of underlying floor.

As it is obvious that the success attending such a method of suture greatly depends on the nature and sterility of the suture material itself, it is essential when advocating sole employment of catgut, both as ligature and suture in aseptic abdominal wounds, not to ignore the ominous fact that catgut has almost rivalled eczema in the number of methods advocated, from time to time, for its "cure." And probably this was one of the reasons which induced Sir John Bland Sutton to state that "there were more people done to death annually by catgut, under the name of surgery, than by a hemp rope, under the name of justice." I confess, at the time, I thought that he exaggerated its lethal powers, but some years later this opinion was shaken by the personal experience of two deaths from tetanus, within twelve months, following the one operation, above all others, in which the greatest antiseptic precautions are taken—simple radical cure of inguinal hernia, in which catgut is always used in quantity. (These two instances constitute my total experience of tetanus under such conditions.)

Although a subsequent laboratory inquisition (including rats) on our stock of catgut returned a verdict of "not proven," the phenomenon demanded change of some sort; all known methods, including Lister's and

Macewen's, were jettisonized, and the one which I am about to describe substituted.

I wish here to thank the hospital pharmaceutist, Señor Paola, for his most patient and valuable assistance and suggestions during the various experiments which led up to a standard result.

(1) Raw catgut, free from fat, as supplied by surgical stores, is wound into loose rolls and placed in a Mayo Robson's or Jellett's bomb, which is almost filled with a mixture of equal parts of ether and alcohol, and boiled for half to one hour (according to size of catgut) in a kettle of boiling water.

(2) The catgut is then removed, with sterilized forceps, and placed in a solution of alcohol 90 per cent. and formalin (40 per cent. strength) 10 per cent.

It is retained in this mixture for forty-eight hours.

(3) It is then immersed and washed in a small basin of ether for half to one hour, according to size.

(4) And finally, stored in glass bottles filled with equal parts of ether and alcohol until required for use.

This catgut has been tested in the independent government laboratory, and reported to be absolutely sterile, and I can clinically guarantee that it is an ideal suture material, clean, tensile, non-irritant, and amply durable (ten to twenty days). And, moreover, is extraordinarily resistant to external infection, as proved by its service in cases of circumcision, hemorrhoids, colporrhaphy, etc.

This thesis would probably be incomplete without some reference as to how I disinfect my hands, irrespective of the use of dry heat sterilized rubber gloves for operation. After a liberal use of nail scissors, the hands and forearms are scrubbed, for five minutes, with nail brush and soap in a running stream of hot water. Then washed in a hot watery solution of formalin (1 in 200). Next submerged, for a few minutes, in alcoholic mercurial lotion (1 in 1000) and just preceding, and during, operation rinsed in a basin of mercurial lotion (1 in 2000).

As post-operative sepsis, like the zero in roulette, will probably give a 1 in 37 ratio, it may be apropos to mention that when it turns up, the wound is at once laid freely open, irrigated with hot peroxide lotion (60–120 c.c. to litre), immediately followed by hot carbolic lotion (15 c.c. to litre), and a hot mercurial fomentation, wrung dry, applied.

This formula is repeated three times daily until the wound becomes aseptic, when it is united by a few catgut sutures, or drawn together by strapping. As I never bury unabsorbable sutures or ligatures in the abdominal wall, the septic process is usually of short duration.

Finally, as to after-treatment, I have only one suggestion to make, keep the part at rest for fourteen days, as this was taught in Trinity College to be the minimum time necessary for the physiological *restitutio ad integrum* of any solution of continuity of body tissue. It is a practice in which I have the most profound belief.

RESECTION OF THE LARGE BOWEL AT THE RECTOSIGMOIDAL JUNCTION*

By Stanley Stillman, M.D.
of San Francisco, Cal.

Resection of portions of the large bowel, or even the whole of it, is accomplished to-day without particular difficulty and in accordance with well-recognized principles: the same is true of the rectum, but it is occasionally one's fortune or misfortune to encounter an obstruction or disease of the large bowel which involves both the rectum and the sigmoid and for which resection is required. It is not necessary to enlarge on the technical difficulties encountered in performing a resection of this portion of the bowel and making an anastomosis below the brim of the pelvis, when the bowels are distended as the result of complete or incomplete obstruction. They are such, however, that one usually resorts to colostomy at once and reserves the resection and anastomosis for a later operation. Yet this very distention of the bowel may be utilized, except in extreme cases, and both resection and anastomosis done in the limited time permitted by the patient's condition at the time.

In most cases carcinoma in this situation is the condition necessitating the operation, but I have been obliged to do it for perforation of the sigmoid at this point, the result of a false diverticulitis, and another time for obstruction following dense adhesions at this point, the result of a previous pelvic operation.

Whether the method, to be described, of dealing with it has the merit of novelty or not, I am unaware, but it has proven singularly successful in my hands, and if it has not this merit it certainly has others to which I wish to subscribe. It is practically the same method that I have used successfully a few times in cases of cancer of the rectum proper, when the external sphincter could be preserved.

In those cases in which the location of the growth or obstruction can be determined beforehand, and in which the obstruction is practically complete, the sphincter should be stretched and the rectum thoroughly washed out and lightly packed with a strip of gauze before the abdomen is opened. In other cases this should not be done till after the abdomen has been opened and a clamp applied to the sigmoid above the point of section after milking back the contents.

The next step is the section of the sigmoid above the obstruction and invagination of the proximal end by means of a purse-string suture of Pagenstecher, the ends of which are left long, after which the clamp is removed, and the sigmoid mobilized sufficiently by ligation of its mesentery, if necessary to reach well below the line of section of the rectum. It is then kept out

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of the way by pads till the resection of the involved bowel is completed. The section through the rectum is made after steadying and keeping apart its walls by means of several stay sutures passed through its peritoneal coat below and close to the line of section. With the proper distribution of pads and the exercise of a little care and ingenuity in controlling the escape of blood and intestinal contents, both these lines of section and the removal of the involved bowel can be accomplished with a minimum of soiling. The packing is now withdrawn from the rectum through the anus, and if desired, several strips may be drawn through the anus from above by attaching them together with sutures. After hemorrhage is arrested the exposed mucous membrane of the upper part of the rectum is wiped clean with moist sponges and painted with iodin for a distance of two or three inches, being held open all this time by the traction sutures.

With a little care and a pair of Mayo scissors and forceps, the mucosa can now be removed for an inch down the rectum, or more if possible, and the hemorrhage arrested without the use of ligatures, if possible. The end of the purse-string suture closing the end of the sigmoid is now attached to a thread previously fastened to the last strip of gauze drawn through the anus and, by traction in this by an assistant aided by a hand in the pelvis, the sigmoid is drawn well into the rectum. The suture is passed through the skin outside the anus and tied so as to fix the end of the sigmoid, but not to pull too much on it. Eight or ten sutures are now applied approximating the upper edge of the rectum to the surface of the sigmoid. If the patient is a woman, a dressed tube is passed through a counter opening into the vagina, or if a man, is brought out below the tip of the coccyx and the abdomen closed. Finally a large tube is placed in the anus.

The closed end of the sigmoid sometimes opens spontaneously, but usually requires opening with a knife or scissors through a speculum.

If the general condition of the patient permits, I prefer not to open it for four or five days, even though the patient may suffer some from symptoms of obstruction of the bowel. This procedure was followed by me first, a number of years ago, as an emergency one in a case of complete intestinal obstruction and was so successful that I have employed it since as the method of choice. I think the essential thing for its success is the distention of the closed sigmoid with gas or fluid which keeps the peritoneal surface of the sigmoid in contact with the raw surface of the rectum long enough for firm adhesions to form—secretions or blood are not confined between the surfaces, but can escape into the rectum freely. In the same procedure—applied to cancer of the rectum proper—the protruding sigmoid generally sloughs to a considerable extent within and even above the sphincter, though its blood supply may seem good at the time. I have not seen this happen in the higher operation, for the sigmoid does not have to be freed so much that its blood supply need be jeopardized at all, or at any rate, not so much that it cannot stand the distention.

In those cases in which the obstruction is complete and of such long

standing that the sigmoid is enormously distended, the condition of the patient may be such that immediate colostomy is necessary. In this event, after the colostomy, there is time and opportunity for preparation of the bowel above and below the obstruction, and either end-to-end suture or implantation may perhaps be safely done, but I have had no more trying, difficult, tedious and uncertain work to do than this within the abdomen. While I am a sincere advocate of two-stage operations in general, when the indications are clear, I am quite the contrary, otherwise, and much prefer to take some chances and avoid two operations if possible. Particularly do I feel averse to a temporary colostomy, and rarely have done one without first opening the abdomen in the midline to see if it could not be avoided.

In case of disease or obstruction of the large bowel at the location under consideration, the procedure above given, so far as my knowledge goes, is the only one that gives a reasonable chance of success without a preliminary colostomy. As a matter of fact, it is comparable to a two-stage colostomy into the rectum. The procedure in question can be done as rapidly as an ordinary lateral anastomosis in a more favorable situation and without much more danger of infection than the first step of a colostomy. Of 8 cases in which I have followed this procedure, 1 died from peritonitis, the result, I think, of the spontaneous opening of the sigmoid on the second day. In 2 cases, one a man and the other a woman, there was fecal discharge through the drainage tube, in one quite profuse, but in both cases the fistulæ healed spontaneously in a few weeks. The portion of the sigmoid projecting into the rectum contracts and in some cases subsequent dilatation is required. The fact that both sigmoid and rectum are dilated while adhesion is taking place may explain why no difficulty has been observed from stenosis at the line of union as is usual in resection of the rectum with end-to-end suture through Kraske's incision.

In 6 of the cases the operation was done for cancer. In 1 of these in which the sigmoid alone was involved in the growth, there was no recurrence after three years. Of 2 in which both rectum and sigmoid were involved, in one there is no evidence of recurrence after six months. The other was living and free from recurrence five years after operation when last seen. One patient died after a year of pneumonia. In this case both rectum and sigmoid were involved, but there was no evidence of either local or general recurrence three months before death when last seen. The other 2 in which both rectum and sigmoid were involved, died within a year of local and general carcinosis.

RECORD OF CASES

CASE I.—Operation at City and County Hospital. Records destroyed in fire of 1906. Patient was a woman with obstruction of the bowels with moderate distention, but without acute symptoms. A mid-line incision was made and the obstruction was found due to an annular carcinoma of the sigmoid just above brim of the pelvis. In the manipulation the gut separated in the middle of the constriction

without leakage from either end. A clamp was immediately applied to sigmoid and its mesentery ligated sufficiently to permit of resection above the growth and closure of its end with double row of sutures; the intention being to do a lateral anastomosis of sigmoid to the anterior wall of the rectum. The portion of the growth remaining was then removed, the line of section through the rectum passing below the brim of the pelvis. While endeavoring to close the end of the rectum before making the anastomosis the patient's condition became bad and great difficulty was experienced in keeping the bowels out of the way. In desperation I abandoned the plan of anastomosis and rapidly removed the mucosa from the upper part of the rectum, slipped the sutured end of the sigmoid into it, removed the clamp and sutured the edge of the raw surface of the rectum to the sigmoid with catgut sutures. An opening in the vault of the regina was then made and iodoform gauze drains inserted, passing to each side of the rectum below the suture line. She did not suffer from the continued intestinal obstruction and after several days the closed end of the sigmoid gave way spontaneously, which was fortunate, as it was beyond the reach of my finger or vision with the specola we then had. There was no fecal discharge following removal of the drain. Nine months or so later she was without signs of recurrence, but was reported a few months later to have died of pneumonia.

CASE II.—Miss D., Lane Hospital, January, 1900. Operation for chronic obstruction of the bowels. Obstruction was found to be due to a small tumor of the sigmoid so close to the brim of the pelvis that in excising it an inch or more of the rectum had to be removed. Many mesentery glands were enlarged and several were included in the meso-sigmoid removed with the tumor. It was decided to try the same procedure described under Case I. The obstruction was not so great as to prevent the bowels being thoroughly cleaned out previous to operation. Previous to doing the resection the sphincter was stretched and the rectum washed out through a speculum and packed with gauze. The sutured end of the sigmoid was drawn in to the denuded rectum by a stay suture which was fastened to the skin outside of the anus. The sigmoid opened spontaneously on the sixth day. There was no fecal discharge after removing the drain. The pathological report was typical adenocarcinoma, but the enlarged glands showed no metastases. The patient was in good health three years later when last seen.

CASE III.—Mrs. S., Lane Hospital, July, 1900. Admitted with symptoms of acute intestinal obstruction. There was a previous history of pelvic pain and intestinal cramp. Pelvic examination disclosed tender masses in both ovarian regions. Mid-line incision. There was free peritoneal fluid and the pelvis was full of adhesions. The right tube was greatly enlarged and thickened and both ovaries enlarged. Adhesions were dense and much sharp dissection required. The obstruction was found due to angulation and adhesion of the small bowel. In removing right tube and ovary rectum was torn open at brim of pelvis and suture of the opening was not possible on account of rigidity and œdema of the rectal wall. It was finally decided to repeat the operation

described in Case I. Numerous high enemata had been given before operation in the hope of relieving the obstruction, so both rectum and sigmoid were empty. Section of the sigmoid was made at a point where its walls were normal and section of the rectum was some distance below the brim of the pelvis. Rectal mucosa was removed and the closed end of the sigmoid was drawn into the rectum by a suture passed through the stump of its mesentery and fastened to the skin outside of the anus. On the fourth day the bowel opened spontaneously and on removal of the drain from the vagina the following day pieces came through the opening. A tubular drain was inserted in the drainage opening and sutured to the vagina. The sphincter was stretched and a large tube left in the anus. The discharge from the regina continued for several weeks and then ceased and the drain was removed. The patient was discharged and disappeared from observation. Microscopical examination of the removed tube showed many tubercles in its mucosa, but there were none noticed in the peritoneum at operation.

Case IV.—Mr. A. I. O., Lane Hospital, May, 1903. Carcinoma of the rectum just palpable by tip of finger when patient strained. Abdominal incision. Large tumor at brim of pelvis envolving both rectum and sigmoid. Resection of tumor and implantation of closed sigmoid into denuded rectum. The protruding end of the sigmoid could be felt in the rectum and was opened with a scalpel on the fourth day on account of general abdominal distention and vomiting. No fecal discharge on removal of drain. Patient left the hospital on the twenty-seventh day. Pathological report: Alveolar carcinoma. Patient died the following year from both local and general recurrence.

Case V.—Mrs. C. H., Lane Hospital, September, 1903. Patient came for relief of hemorrhoids. Examination showed blood and mucus coming from high up the rectum, but no growth could be felt or seen by the speculum. There were no symptoms of obstruction of the bowels. Abdominal incision disclosed a hard mass in the wall of the rectum at the junction of the sigmoid. Resection of involved rectum and sigmoid and invagination of the sutured end of the sigmoid as described in Case I. Removal of vaginal drain followed by fecal discharge lasting for four weeks. Patient died a year later from general carcinosis.

Case VI.—City and County Hospital. Records lost in the fire of 1906. Patient was a heavy man operated on for what was supposed to be appendicitis. The greatest tenderness was near the mid-line and under the anæsthetic an ill-defined mass could be made out by rectal examination. A mid-line incision was made and the mass found to have no connection with the appendix, but due to a small abscess between the sigmoid and rectum near the brim of the pelvis. There was an opening into the sigmoid communicating with the abscess and the case was regarded as one of cancer with spontaneous perforation. Involved sigmoid and rectum were removed and the closed end of the sigmoid pulled into the denuded rectum as previously described. The rectal wall was œdematous and rigid at the point of section and bleeding was serious. On the second day after operation fæces came through the rectum and the man died of peritonitis from fæces escaping into the

pelvis. The mass proved to be inflammatory and I have since concluded that it was a case of false diverticulitis, condition of which I was ignorant at the time.

Case VII.—Mr. H. A. S., Lane Hospital, October, 1909. Growth in the rectum beyond reach of finger but visible with proctoscope. Abdominal incision. Tumor of upper part of rectum was found involving the sigmoid. Resection included upper part of rectum and lower part of sigmoid. Denudation of rectum and invagination of closed end of sigmoid was done. Drainage inserted through counter-opening at tip of coccyx. Spontaneous opening and discharge of fæces on the fifth day. No fecal discharge followed removal of drain. Pathologist's report was adenocarcinoma. Patient seen last in 1914 and presented no evidence of recurrence.

Case VIII.—Mrs. F., Dameron Hospital, Stockton, Cal., November, 1916. High rectal carcinoma, lower border just palpable with tip of finger when patient was under anæsthetic. Abdominal incision. Resection of 3 inches of upper part of rectum and lower part of sigmoid. Denudation of rectum and invagination of closed sigmoid. Sigmoid opened with scalpel on fifth day on account of vomiting. Fecal discharge followed removal of vaginal drain, but ceased in about two weeks. Reported to be without signs of recurrence and in excellent health after ten months. Pathological report was adenocarcinoma.

LEFT PARADUODENAL HERNIA*

By A. U. Desjardins, M.D.

Fellow on the Mayo Foundation, Rochester, Minn.

Several varieties of paraduodenal hernia have been observed and described. Such herniæ are of considerable importance to the surgeon, because, although rarely recognized before death or before an operation for the relief of obstructive or strangulation phenomena, they may be encountered in the course of operations undertaken for the treatment of more or less commonplace abdominal disturbances. The majority of cases thus far reported have been discovered during the course of post-mortem examinations of persons having died from causes in no way associated with the hernia. A few cases are on record in which the surgeon, operating for the relief of obstruction or strangulation, found the hernia and successfully dealt with it.

The first real contribution to our understanding of this type of hernia we owe to Treitz, whose work dates back to 1857. Unfortunately, in his description of a fossa which he called "duodenojejunal," he included what is now considered a second fossa, the "paraduodenal" fossa of Landzert. Later Broesike, Gruber, Waldeyer, Landzert, and Jonnesco added greatly to our knowledge of the subject, but in so doing confused it to some extent by describing the same fossæ under different names and different fossæ under the same names, so that to review the literature would be tedious indeed were it not for the admirable monograph of Moynihan.

The terms "duodenal" and "duodenojejunal," which have been applied to this type of hernia, are somewhat misleading and might be thought to imply a displacement of the duodenum into some adventitious sac, but such is not the case; it refers to a hernia of the entire small bowel, or some part of it, into a sac derived from folds of peritoneum and fossæ normally to be found about the terminal, or fourth, portion of the duodenum. For that reason I prefer to use the term "paraduodenal" which is more accurate.

Inasmuch as a clear understanding of this type of retroperitoneal hernia involves a knowledge of the anatomy of various folds and fossæ adjacent to the fourth duodenal segment, these fossæ and their relations will be briefly described.

Paraduodenal Folds and Fossæ.—If the great omentum and transverse colon are reflected and pulled upward over the costal arch, and slight traction downward and to the right is made upon the jejunum, there will be seen passing from the peritoneal surface of the superior or, in some cases, of the anterosuperior, aspect of the duodenojejunal angle upward, forward and to the left side, a thin-edged, peritoneum-covered fold, the lower attachment of which is lost in the peritoneum covering this portion of the gut, the

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upper attachment blending with the root of the transverse mesocolon adjoining the splenic flexure. This is the ligament of Treitz. Its thin anterior edge is concave upward, and slightly toward the right side and the middle, narrower, portion crosses over the inferior mesenteric vein in an oblique direction upward and to the left. In the substance of this fold are involuntary muscle fibres derived from the left crus of the diaphragm. With the viscera *in situ* this fold cannot be made out, and traction upward on the colon and downward and to the right on the jejunum is necessary to bring it out.

With the colon reflected and the small bowel pulled over to the right as described, there appear in most bodies, immediately to the left of the fourth portion of the duodenum, one or more fossæ bounded by definite folds of peritoneum. Jonnesco describes in his work five fossæ. Moynihan describes nine, four of which, however, he considers of little importance.

The fossæ most frequently encountered in a consecutive examination of 100 bodies ranging in age from birth to seventy-five years are, in order of frequency:

1. Inferior paraduodenal fossa of Treitz ..... 60 per cent.
2. Combined superior and inferior paraduodenal fossæ.... 30 per cent.
3. Superior paraduodenal fossa ..... 5 per cent.
4. Paraduodenal fossa of Landzert ..... 2 per cent.
5. Duodenojejunal or mesocolic fossa ..... 2 per cent.
6. Fossa of Waldeyer ..... 1 per cent.

I have not been able to study these fossæ in the embryo, at which time they are said to be more frequent.

The Superior Paraduodenal Fossa.—Below the ligament of Treitz and on a plane posterior to it, immediately to the left of the duodenojejunal angle, there can be seen in many bodies a thin, sometimes almost transparent, fold of peritoneum extending from the peritoneal surface of the terminal portion of the duodenum toward the left, a distance of from 1 to 2 cm. This fold is, in a general way, triangular in shape, and is bounded below by a thin, semilunar margin, the concavity of which is directed downward and to the left. This fold forms the anterior boundary of a triangular fossa, usually from 1 to 2 cm. deep, the apex of which is directed upward or upward and slightly to the right and is in close relation to the pancreas. The fossa is bounded on the right by the terminal portion of the duodenum and on the left by the line of fusion between the fold and the posterior parietal peritoneum just to the right of the inferior mesenteric vein which courses in a gentle curve along the left side of the fossa (Fig. 1). This has been called by different writers the duodenal, duodenojejunal, or the superior duodenal fossa, but inasmuch as all these fossæ are *para*duodenal, I shall call it the superior paraduodenal fossa.

The Inferior Paraduodenal Fossa of Treitz.—A short distance below the orifice of this superior fossa there is still more frequently another fossa bounded anteriorly by a reflection from the peritoneal investment of the fourth portion of the duodenum, posteriorly by the posterior parietal peri-

FIG. 1.—The superior and inferior paraduodenal folds and fossa, and the submesenteric fossa (Landzert).

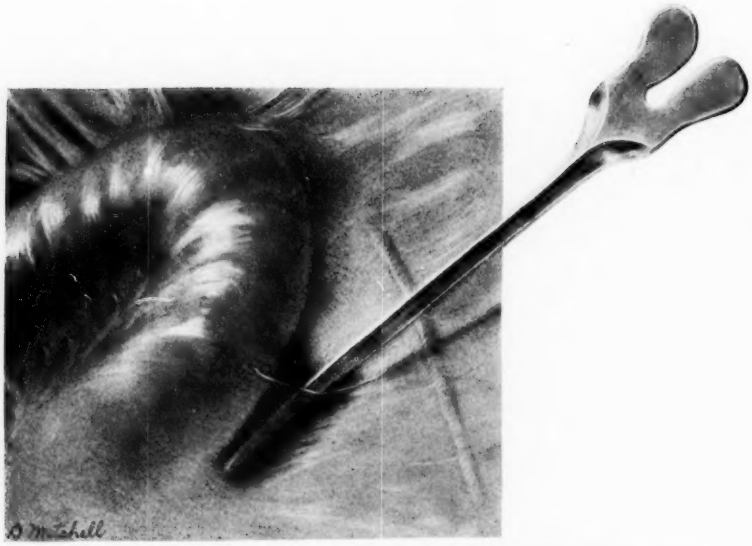

FIG. 2.—Inferior paraduodenal fossa (Treitz); director inserted into the fossa.

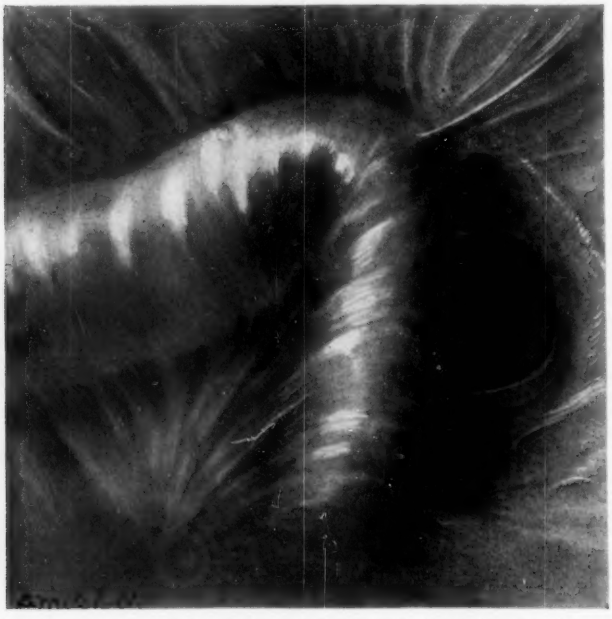

FIG. 3.—Superior and inferior paraduodenal fossæ with left ends of folds fused to form a common orifice for both fossæ.

FIG. 4.—Paraduodenal fossa of Landzert, showing the inferior mesenteric vein running downwards in the edge of the fold.

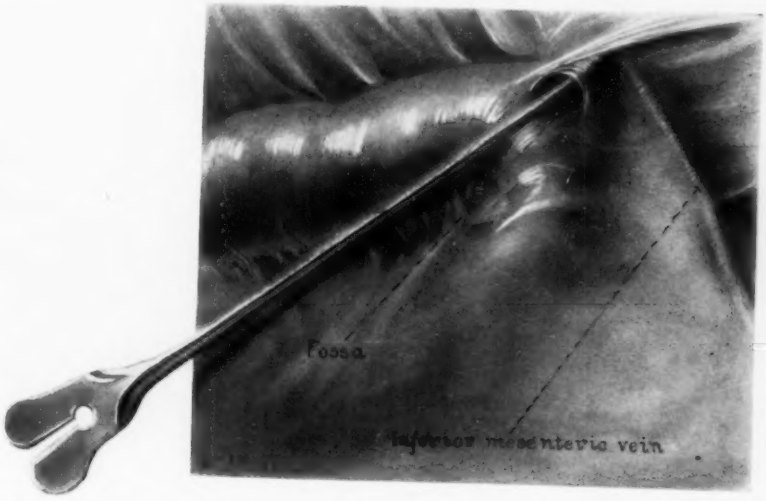

FIG. 5.—Mesocolic type of fossa with duodenojejunal angle buried in the transverse mesocolon.

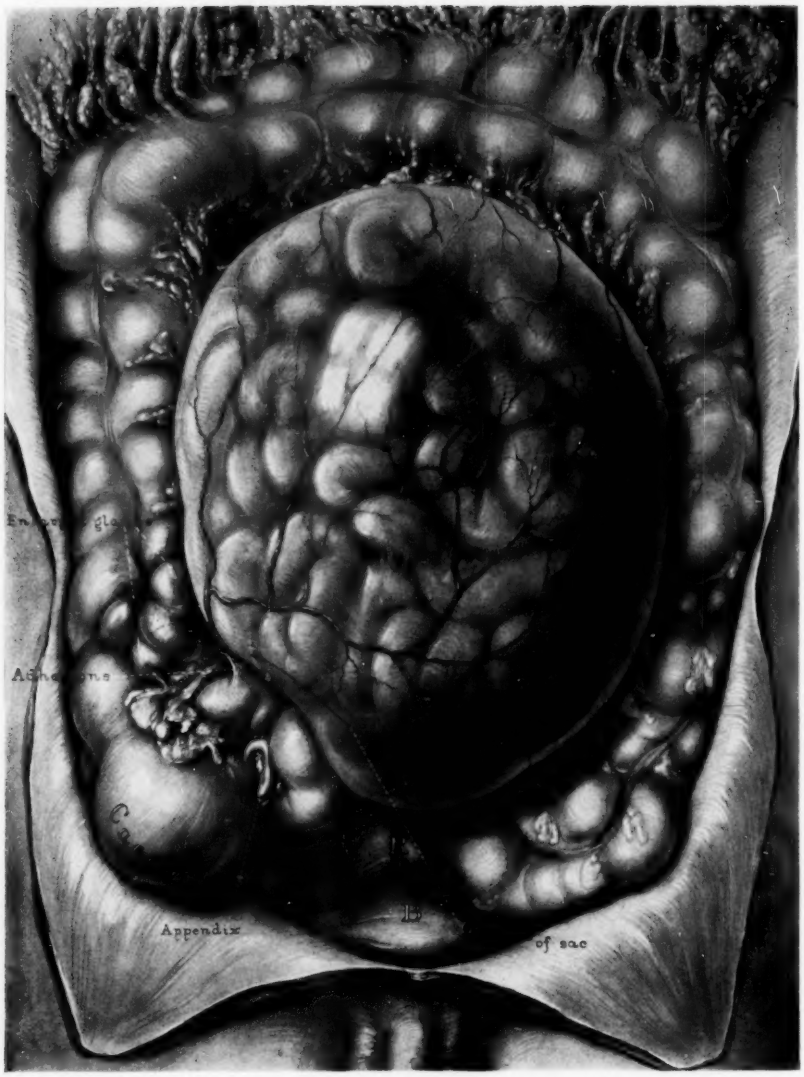

FIG. 6.—Left paraduodenal hernia as seen at autopsy. The sac contains the entire small bowel, except the terminal five inches.

toneum, on the right side by the duodenum and on the left by the line of fusion between the fold and the parietal peritoneum. The upper margin of this fold is semilunar with its concavity directed upward or upward and slightly to the left, and forms the anterior margin of the opening of a fossa of variable depth, the apex or bottom of which is directed downward and to the right immediately adjoining the fourth portion of the duodenum (Fig. 2). This is the inferior paraduodenal fossa and corresponds to the fossa described by Treitz and named by him "duodenojejunal." Moynihan describes it as the inferior duodenal fossa.

The exact position and depth of this fossa vary more or less. In three instances I was able to introduce my little finger into the fossa to a depth of 5 cm. Its usual position is along the left edge of the body of the third lumbar vertebra. In many bodies the superior and inferior fossæ coexist, and in one case the left ends of the folds forming the anterior boundary of the orifices of both fossæ had become fused into one, resulting in a common opening for both fossæ (Fig. 3).

At a variable distance below the apex of the inferior fossa the left colic artery, coursing upward and to the left, crosses the inferior mesenteric vein, the two vessels constituting the *vascular arch of Treitz*. This arch is of fundamental importance because the relations of these vessels to the neck of a hernia in this region determine its variety.

The Paraduodenal Fossa of Landzert.—The paraduodenal fossa of Landzert is produced by a dipping of the posterior parietal peritoneum around the right side of and behind the inferior mesenteric vein as it curves downward a short distance to the left of the fourth duodenal segment. This dipping of the peritoneum about the vein gives to the vessel a mesentery, so to speak, the vein arching to the left and then downward in the edge of the fold, the fossa being beneath or posterior to it (Fig. 4). This fossa is of great importance because it is that in which most of the paraduodenal herniæ reported have occurred, as determined by the relations of the inferior mesenteric vein and left colic artery to the neck of the sac. The extent of the fossa of Landzert varies considerably and its exact boundaries are not easy to determine because, as pointed out by Moynihan, "it exists not seldom in conjunction with other fossæ. The complications are almost as frequent as the normal." When such a complication occurs it is most frequently in the form of an associated superior paraduodenal fossa.

The Paraduodenojejunal Fossa.—The duodenojejunal fossa, identical with the *fossette duodéno-jéjunale ou mésocolique* of Jonnesco, is the only one of the paraduodenal fossæ which have been miscalled "duodenojejunal," to really deserve the name. In the cases in which the fossa is encountered the duodenojejunal angle is buried in the root of the transverse mesocolon, the anterior leaf of which extends farther down over the anterosuperior aspect of the duodenojejunal angle where it fuses with the peritoneal investment of this portion of the gut. In this anterior leaf of the mesocolon, just above the line of fusion, there may be seen an arched opening, in some cases so

flattened against the bowel wall as to require the introduction of a probe in order to demonstrate the fossa. The direction of the cavity is upward and to the left, the bottom of the fossa being in close relation to the pancreas and inferior mesenteric vein (Fig. 5). Jonnesco describes a similar fossa with a double opening which is merely a modification. This duodenal fossa is to be found in from 5 to 10 per cent. of bodies examined.

The Mesocolic Fossa.—The fossa described under this name by Moynihan is quite uncommon, but it is of some importance as the possible origin of a hernia. It is located at some distance from the ascending fourth portion of the duodenum, to the left of the inferior mesenteric vein, and extends to the left between the leaves of the mesocolon in the region of the splenic flexure. A branch of the left colic artery runs upward in the fold, forming the anterior boundary of the fossa.

The Paraduodenal Fossa of Waldeyer.—Waldeyer, in 1874, described a fossa in the mesojejunum, beneath the superior mesenteric artery and immediately below the duodenum, which he called "mesentericoparietal" and which Moynihan considers of more frequent occurrence than some of the other fossæ described in his work. In 100 bodies examined I have seen it but once, and although the relations of this fossa were those mentioned, I am inclined to consider it as a variation from the more common inferior fossa of Treitz. I have seen a number of low fossæ of Treitz, the bottom or apex of which was in intimate relation to the beginning of the fourth portion of the duodenum, and it does not require a considerable stretching of the imagination to associate the fossa of Waldeyer with a low inferior paraduodenal fossa of Treitz. Moynihan's description is as follows: "The fossa has its orifice to the left, its blind extremity to the right and downward. In front it is bounded by the superior mesenteric artery and behind by the lumbar vertebræ. The peritoneum of the left leaf of the mesentery lines the fossa, that of the right covers the blind end, and is then continued directly into the posterior parietal peritoneum." It is in this fossa that a right paraduodenal hernia occurs, and since we are dealing only with the left type of hernia it will not be referred to again.

Three other fossæ have been described, but they are so rare and of so little importance that they need not be considered.

Origin of Paraduodenal Folds and Fossæ.—Several explanations of the origin of these folds and fossæ have been advanced. The first interpretation was that of Treitz, who considered them to be due to the movement of the intestine associated with its embryonic development. During the early stage of its development the intestinal tract consists of a fairly simple and straight tube attached to the midline of the body by a fold of peritoneum. As it grows the stomach becomes differentiated by a dilatation of the tube, and the tube below this gastric dilatation increases in length. Associated with this development is a movement of the stomach from its original longitudinal position with its surfaces looking to right and left, to a transverse position, the original right surface of the stomach becoming posterior and its former

left surface the anterior. As this movement, with which the duodenum is associated, takes place, there is a gradual fusion of the peritoneum about these structures. Treitz's view was that the increasing length and consequent dragging of the intestine exerting traction on the fixed duodenum and mesocolic root were responsible for these folds, and that the fossæ were the result of these "traction" folds. This view is now quite untenable.

Waldeyer's theory was based on the relation of the inferior mesenteric vein to the neck of the sac. He thought that, in the course of development of the posterior parietal peritoneum, the vein raised a fold forming a fossa, and for that reason he considered the fold as *vascular* in origin. This view cannot be accepted because there are several folds and fossæ which have no such vascular relationships.

The logical explanation, which covers the embryologic and anatomic requirements, is that of Moynihan, who looks on them as "fusion folds between the original left, afterwards anterior, surface of the ascending portion of the duodenum and the right, or anterior surface of the descending mesocolon folds, which date their origin from the time when these two peritoneal surfaces are in close apposition." This interpretation makes it possible to understand the frequent occurrence of atypical fossæ.

Factors Involved in the Production of Hernia.—Treitz has formulated three postulates as indispensable for the occurrence of a left duodenal hernia:

1. The presence of a fossa.
2. The presence of the neck of the sac of the inferior mesenteric vein.
3. Sufficient mobility of the small bowel to allow it to pass into the sac derived from this fossa.

However, it would seem that, beside these factors, there would be required an increased intra-abdominal pressure sufficient to initiate the hernia, because the natural drag of the intestine is away from these fossæ, the opening of which is seldom large. It is conceivable that in some cases the hernia may be congenital, having been produced as a result of increased intra-abdominal tension either before or during parturition.

The second postulate may or may not be fulfilled, depending on whether or not the hernia is one into the paraduodenal fossa of Landzert, because this is the only fossa with which the vein is in such close relation.

Report of a Case of Left Paraduodenal Hernia.—Case 193232 is that of a man fifty-six years of age, who came to the Mayo Clinic May 4, 1917, seeking relief for shortness of breath and abdominal distention. Physical examination revealed an enlargement of the right lobe of the thyroid, multiple firm, nodular masses in the upper abdomen, an enlarged, palpable spleen, and a large quantity of fluid in the left pleural cavity causing a considerable displacement of the heart to the right. On the same day a supraclavicular gland was removed for microscopic examination and proved to be lymphosarcomatous. I merely mention these facts without dwelling on them because they have no bearing on the hernia, except to show that the patient had never had any symptoms

that might lead one to suspect the presence of an abdominal condition in no way responsible for his death, which occurred on May 8.

At the necropsy performed fifteen hours after death the following pertinent lesions were named as the lethal factors in the anatomic diagnosis: Marked general lymphosarcomatosis; chronic nephritis; cardiac hypertrophy and bilateral hæmohydrothorax.

The following is a transcript of the description of the hernia made at the time:

"On opening the abdominal cavity the small intestine appears as in the early stage of a plastic peritonitis. The coils seem slightly adherent, and hyperæmic, but it is strikingly noteworthy that the intestinal mass has a sharply ovoid shape, smooth and uniformly rounded, occupying the centre of the abdominal cavity with the colon forming a frame about it as shown in Fig. 6. On attempting to separate some of the coils, however, it is at once apparent that the bowel is covered by a thin, transparent membrane in which vessels can be seen coursing from above downward and from below upward. The mass is about the size of a human head looked at from above; it measures over all 20 cm. in its longitudinal diameter and 17 cm. in the transverse. There is an interval of 5 cm. between the lower pole of the mass and the symphysis pubis. Recognizing a hernial sac and seeking its orifice, I find it above and behind the lower pole and to the right of the middle line, in the form of a long, oblique opening slightly semilunar, with its concavity pointing downward and to the right. The anterior margin of the neck of the sac is thick and cord-like and passes upward and to the right to the space between the sac and the ascending colon where it becomes lost in the retroperitoneal tissues, among masses of enlarged glands. At the left and inferior end of the opening the cord-like anterior margin of the neck curves upward and to the left to blend with the descending mesocolon. Four fingers can be readily introduced into this orifice up to the metacarpophalangeal joints. Traction on the lower pole upward and to the left brings the orifice into view and it is seen that the entire small bowel, with the exception of the terminal 5 inches of ileum, is inside the hernial sac. There are no adhesions between the bowel and the sac.

"The normal anatomic relations are so distorted by the enormous enlargement of all the retroperitoneal lymph-glands that, in order to determine the variety of this hernia, it is necessary to work out the relations of the inferior mesenteric vein and left colic artery to the sac. The inferior mesenteric vein passes beneath the posterior parietal peritoneum across the back of the hernial sac to the space between it and the ascending colon on the right side. Then coursing downward and inward to the right margin of the hernial orifice it passes from right to left in the thickened anterior margin, forming the anterior boundary of the neck to the left side.

"The left colic artery runs toward the left side, where, after coursing downward in the space between the sac and the descending colon, it enters the left side of the anterior margin of the hernial orifice and passes through it upward and to the right side. From both vessels as

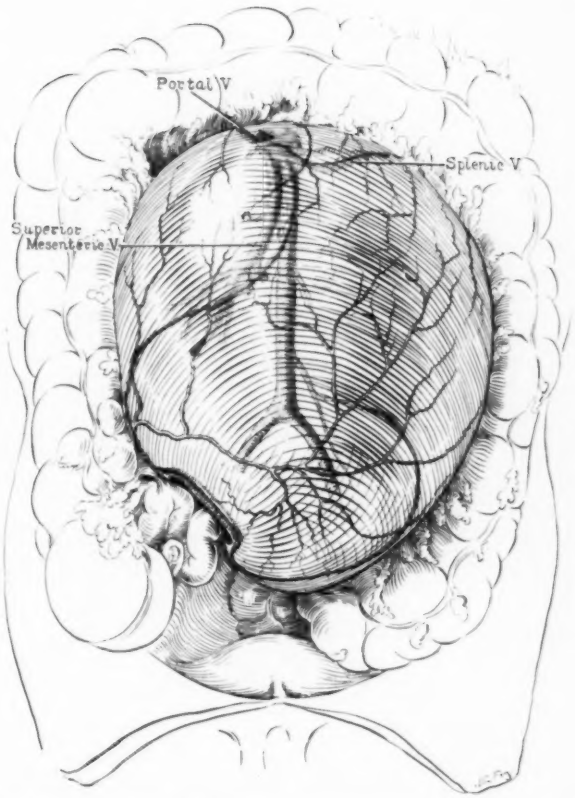

FIG. 7.—Diagram showing the relations of the inferior mesenteric vein and left colic artery to the hernial sac.

they pass through the thickened band forming the anterior margin of the neck of the sac, branches pass upward between the two fused layers of the sac itself. Similar branches pass downward from the middle and left colic vessels, running in the space between the sac and the transverse and descending colon."

The accompanying diagram (Fig. 7) gives a better idea of these relations. This, then, is a hernia into the paraduodenal fossa of Landzert and is to be classified as a left paraduodenal hernia.

In his monograph published in 1906 Moynihan gives a list of 65 cases reported up to that time. Since then A. Rendle Short has collected 17 more cases, one of which, however, had already been reported by Moynihan, making, up to 1914, a total of 81. Of the 16 cases collected and listed by Short, 7 patients were operated on and recovered. One of these cases, that of Heller, was a complete hernia, very similar to my own.

Since the beginning of 1914 I have been able to gather the four following cases:

1914. Davis, L.: A case of strangulated retroperitoneal hernia of the small intestine into the paraduodenal fossa. *Boston Med. and Surg. Jour.*, 1914, clxx, 272–274.

1914. Nuzum, F., and Nuzum, J.: Two unusual internal herniæ—one intersigmoid, the other into the paraduodenal pouch of Landzert. *Tr. Chicago Path. Soc.*, 1914, ix, 191.

1914. Pybus, F. C.: Symptoms of acute intestinal obstruction operated and cured. *Brit. Med. Jour.*, 1914, ii, 14.

1916. Pringle, J. H.: Report of a case of hernia into the paraduodenal fossa. *Glasgow Med. Jour.*, 1916, lxxxvi, 65–72.

REFERENCES

Broesike, G.: Ueber intraabdominelle Hernien und Bauchfelltaschen. Berlin, 1891.

Gruber, W.: Uber die Hernia interna mesogastrica. St. Petersburg Med. Ztschr., 1861, i, 217–258; 1862, ii, 161–167; 1862, iii, 300–303.

Heller, E.: Ueber eine operative geheilte Hernia duodenojejunalis Treitzii. Archiv. f. klinische Chir., 1909, xc, 361–366.

Jonnesco: Sur l'anatomie topographique du duodenum. Progres Med., 2 s., ix, 176, 216, 233, 257, 271, 288.

Landzert, T.: Ueber die Hernia retroperitonealis und ihre Beziehungen zur Fossa duodeno jejunalis. St. Petersburg Med. Ztschr., 1871, ii, 306–360.

Moynihan, B. G. A.: Retroperitoneal Hernia. Lond., Baillière, 1906, 195 pp.

Poisson, F.: Les fossettes peri-duoden ales et leur role dans la pathogénie des hernies retroperitoneales. Paris, Lille, 1895, 114 pp.

Short, A. R.: A Case of Retroperitoneal Hernia Cured by Operation, with a Report on the Literature of the Subject. Brit. Jour. Surg., 1915–16, iii, 48–54.

Treitz, W.: Hernia retroperitonealis. Ein Beitrag zur Geschichte inneres Hernien. Prag, Credner, 1857, 150 pp.

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1914. PYBUS, F. C.: Symptoms of acute intestinal obstruction operated and cured. *Brit. Med. Jour.*, 1914, ii, 14.

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REFERENCES

Broesike, G.: Ueber intraabdominelle Hernien und Bauchfelltaschen. Berlin, 1891.

Gruber, W.: Uber die Hernia interna mesogastrica. St. Petersburg Med. Ztschr., 1861, i, 217–258; 1862, ii, 161–167; 1862, iii, 300–303.

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Jonnesco: Sur l'anatomie topographique du duodenum. Progres Med., 2 s., ix, 176, 216, 233, 257, 271, 288.

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THE DISTRIBUTION OF FAT IN THE APPENDIX AND ITS RELATION TO INFLAMMATION*

By George M. Smith, M.D.
of Waterbury, Conn.
(From the Surgical Division of the Waterbury Hospital)

The accumulation of visible fat in various regions of the body has long been a matter of study; and much clinical and experimental data are now at hand to show the relation of fat to normal and pathologic processes. With the exception of the blood-vessels, the solid parenchymatous organs have been of chief interest for their variations in content, distribution and nature of fat. It is only in more recent times, with the renewal of interest in the study of lipoids, caused by the application of improved methods of analysis, that some of the hollow organs of the abdominal cavity have become the object of investigation.

It is a matter of general knowledge, particularly since the researches of Rosenfeld,[1] that the visibility of fat in tissues is not necessarily a true index of the entire fat content of the organ, for many of the lipoids found in tissues are held in an invisible combination with other substances, becoming an object of visible demonstration only when chemically liberated from the substances with which they are associated. On the one hand, a kidney showing a marked fatty condition on gross or microscopic examination, when chemically analyzed may show no increase in fat over what is normal. On the other hand, a kidney exhibiting on inspection or by staining methods very little or no fat, may be found to contain an unusually high percentage of fat when chemically examined. For practical purposes, however, any extensive accumulation of visible fat in an organ is regarded as satisfactory evidence of pathologic increase in its content of fat.

Many investigations have been undertaken to explain the process by which an abnormal deposit of fat occurs. In a general way it may be said that the body stores fat in various regions under normal circumstances, and these places are often referred to as "fat depots." The sites for storage of fat vary somewhat at different periods of life; and even the chemical composition of the fat may show variations, depending upon the locality in which the fat is found. Fat depots are in regions such as the panniculus, the fatty capsule of organs, the mesentery and in the tissues of the mammary gland. These regions, as Kawamura[2] has pointed out, are chiefly neutral fat, formed by glycerine esters. Considerable amount of fat exists in the body, however, formed by cholesterine esters, characterized by the physical properties of being doubly refractive or anisotropic, showing a cross of light when examined by polarized light. These fatty globules exist normally in the adrenals, thymus and the lutein cells of the ovary, and are

* Read before the Connecticut State Medical Society, New Haven, Conn., May 24, 1917.

found as abnormal fats in other parts of the body. There is still another large group of fatty substances, called myelin substances, which become visible only under strictly abnormal conditions. When, for instance, as the result of a profound disturbance, tissues become necrobiotic or autolytic, myelin droplets are formed. The term fat phanerosis has been applied to the condition where invisible lipoids become visible under abnormal circumstances.

Organs affected with a pathologic accumulation of fat often show special anatomical areas where the deposit of fat is greatest in amount. In the blood-vessels and in the heart it is characteristically sub-endothelial, although the musculature of both the blood-vessels and the heart may be strikingly affected. In the liver the storage of fat is within the liver cells; while in the pancreas fat forms between the lobules and among the acini. In the appendix, as will be explained, the accumulation of fat appears to be mostly in the submucosa.

The problem of fat accumulation is associated with cellular metabolism, in which oxidation is probably the chief fault. As Wells [3] has pointed out, constituents of fat (as glycerine and fatty acids) are brought to cells through the medium of tissue fluids, and are there converted by the enzyme lipase into the forms of fat useful for the growth and function of the particular cell. The intracellular fat is resolved again into its constituents by other enzymes when occasion demands their use. Anything interfering with the synthesis or with the breaking down of the fats may cause abnormal accumulation of fat either within the cells of an organ, or in neighboring tissues, for lipase is found in all body fluids and may act to form fats at any point where the proper conditions for this process exist. Any severe injury to cells, such as is produced by certain poisons, may cause an abnormal formation of fat in the cells affected. Injury to tissues through inflammation appears also to be associated with fat accumulation. As examples of this it may be said that chronic inflammations of the kidney cause fatty degeneration of renal epithelium. In pneumonic processes of long standing, areas of fatty tissues may occasionally be found. In the periphery of chronic abscesses and edges of growing tumors lipoids can, at times, be demonstrated. Aschoff [4] has pointed out that fatty substances, particularly cholesterine, may be found in the mucous membrane of the gall-bladder when this is the site of inflammation.

As far as can be ascertained by a review of the literature, the relation of fat formation to inflammation of the appendix has not been defined. The occurrence of fat in the appendix was first noted by several of the earlier anatomists, chiefly incidental to the study of the so-called involution of the appendix. The materials for this study were from autopsies. Wolfer [5] was probably the first to note that fatty tissue existed in the obliterating appendix. In a small number of appendices of adults examined by him there was found a loss of mucous membrane of the appendix and the submucosa formed a network of fatty tissue.

Zuckerkandle [6] studied with much care the obliteration of the appendix, contributing a great deal to our knowledge of the histology of this condition. It is not necessary to go into details of his work at the present time, except to point out that he thought the presence of fat played an important part in causing obliteration of the lumen of the appendix. In thirty-seven appendices examined, which had shown an atresia of the lumen, seventeen contained fat; two showed areas of fat and areas without fat; eighteen were without fat, among these nine with a contracting atrophy of the appendix. Zuckerkandle believed that the early evidence of obliteration of the appendix occurred as a great thickening of the submucosa, which was supplied not only with an increased number of blood-vessels but also with fat to such a degree that, on cross section of the appendix, it might look like a lobule of fat. These masses of fat were arranged radially and were traversed by connective tissue. In what he believed represented a somewhat later stage, the connective tissue appeared more dense, nearly or entirely free from fat. The final stage of obliteration Zuckerkandle recognized anatomically as a thin cord-like appendix, with no fat or only an occasional globule.

Suduski [7] also studied autopsy material and found that in young individuals no fat was present in the appendix; while in older subjects, even in the absence of all traces of obliteration, considerable amount of fat might occur. Suduski found appendices showing early obliteration without fat at the site of the lesion. He did not agree therefore with Zuckerkandle's views that an accumulation of fat was associated with an early phase of obliteration. All these investigators regarded the obliteration of the appendix as a process of involution and not of inflammatory origin.

It is generally conceded, at the present time, that what is known as partial or complete obliteration of the appendix is in a large part the outcome of chronic inflammation, which gives rise frequently during life to clinical symptoms, yet often remains clinically unrecognized. Inflammatory changes in the appendix, which are clinically obscure, may begin in early infancy. In 200 appendices in infants under one year, which I had occasion to examine at autopsy, 17 showed histologic evidence of inflammation.[8] MacCarthy,[9] in a study of a vast amount of material, found that partial obliteration might be present as early as the fifth year, and complete obliteration was seen as early as the tenth year. He estimates that the average time necessary for complete obliteration of the lumen of the appendix is approximately four years and believes that inflammatory processes must determine these rapid changes. As is well known, with increasing years, evidence of obliteration is more and more frequent so that, at the end of the sixtieth year, over fifty per cent. of all appendices at autopsy show evidence of this condition.

METHODS AND RESULTS OF STUDY

The present work is based on the gross and microscopic study of 217 appendices removed at operation, gathered principally from the surgical material of the Waterbury and St. Mary's Hospitals. These tissues were

FIG. 1.

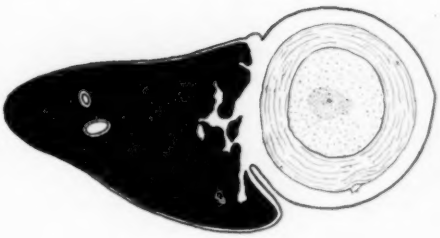


FIG. 2.

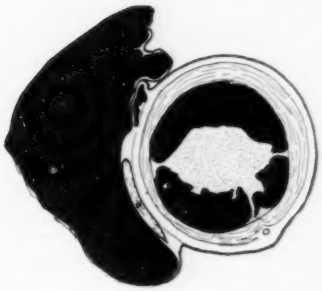
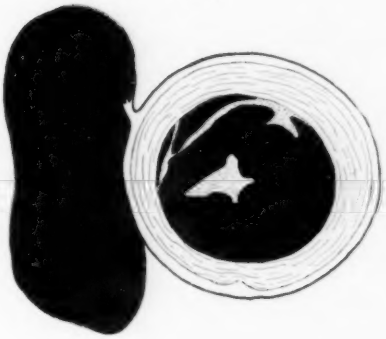


FIG. 3.

FIG. 4.



FIGS. 1–4 are diagrammatical drawings made from cross-sections of gross appendices, chronically inflamed, stained with Scharlach R. for fat. In the figures, black areas represent tissues taking the fat stain. Fig. 1, chronic appendicitis without increase in fat. (Meso-appendix alone takes the stain.) Figs. 2, 3, and 4, chronic appendicitis with marked increase in fat which has accumulated in the thickened submucosa.

fixed in formalin and sectioned transversely with a razor into small segments, 2 to 5 mm. thick. After formalin fixation for 48 hours, the appendices were washed for a half hour and placed in an alcoholic solution of Sudan III or Scharlach R for from two to three days. All fats were stained red by this time and the tissues were then removed and permanently placed in 10 per cent. formalin. Blocks, for microscopic study, were taken from the appendices as a rule before staining the gross tissues in Sudan. Blocks were cut on the freezing microtome and stained with Sudan and mounted in glycerine for study.

A preliminary gross study was made of the entire gastro-intestinal tract, treated in this way, of a normal adult, age 25 years, six feet tall, who died four days after an accident.

It was found that the walls of the œsophagus in this individual contained no visible fat. The wall of the stomach was also fat free, except in a few of the larger folds of the stomach where fat was present in very moderate amounts situated in the submucosa. There were small amounts of fat in the submucosa of the pylorus. The duodenum, jejunum and ileum did not stain for fat. The ileocæcal valve, however, showed considerable amounts of fat. The cæcum, the colon, the sigmoid and the rectum showed definite yet moderate amounts of fat in the submucosa. The ileocæcal valve was most conspicuous for its content of fat. In four other specimens, removed at autopsy, fat in the ileocæcal valve seemed abundantly present. The appendix of this normal individual was patent throughout and showed fat here and there in the submucosa, especially at its base and in the fold corresponding to the valve of Gerlach. The extreme tip was fat-free.

It would seem from this single study of what approaches normal adult conditions as closely as possible that any large fold or valve of the gastro-intestinal tract may contain fat, and that fat forms part of the structure of the submucosa of the large intestine and the appendix. In the fœtus and in the infant this fat was not visible in either the cæcum or the appendix. In ten appendices belonging to late fetal life or early infancy, no visible fat was demonstrated in either the cæcum or the appendix. This is in harmony with the view of Suduski, who believes that fat makes its appearance after birth and is present, to some extent, in all appendices of adults.

There were 132 appendices examined, removed for disease of the appendix, which could be classified as chronic appendicitis. It was apparent at once that the deposit of fat was an important feature of the obliterative process. In most of these appendices fat was present, and this varied in amount over a wide range. In some appendices fat was absent or nearly absent; in others fat was extreme and formed the most conspicuous feature of the lesion. It would appear from this, that chronic appendicitis actually divides itself into two groups; the first exhibiting no increase in fat, the second showing an unusual accumulation of visible fat. It was more common to find that the region at the base of the appendix was affected and contained more fat than did the tip, even though it is common knowledge

that obliterative changes often make their earliest appearance in the distal end of the appendix. At sites of stricture fat was found more often than not; yet it was almost the rule that the fat, at the points of stricture, was no greater in amount than elsewhere in the appendix. Twelve cases out of 154 cases of chronic appendicitis, showed a marked condition of fat accumulation. These fatty appendices all exhibited a tendency to obliteration of the lumen. Histologically the fat was in large masses or small globules in all parts of the thickened submucosa, which encroached upon or filled the lumen. Fat globules were found between the muscle bundles or actually in the muscle substance, slight amounts occasionally in the serosa. A striking feature was the massing of fat about the blood-vessels, and this fact suggests the possibility that circulatory disturbances play a rôle in the origin of fat. The mucous membrane showed little fat, except that the epithelial cells may contain fatty granules as they do under normal circumstances when absorbing fat from the content of the intestine. When epithelium contained fat it was usually in small groups of cells scattered here and there, particularly those deep in the folds of the mucous membrane.

Clinically this condition of fatty appendix occurred in the male sex six times, in the female thirteen times. In several of these patients there was a tendency to obesity. It was seen as early as the sixteenth year, while the oldest patient exhibiting the condition in this series was 42 years of age. The condition of fat in the meso-appendix was no index of the extent of fatty involvement in the appendix itself. In one patient the condition was associated with chronic cholecystitis with stones, in another with chronic salpingitis. The wall of the gall-bladder showed a slight amount of fat, the tube showed none. The clinical histories of patients with fatty appendices appeared to differ in no way from that of the usual chronic case of appendicitis. From the histological study of these appendices one gets the impression that there is a great massing of fat about the blood-vessels and lymphatics, particularly the former. This would point to the possibility that circulatory disturbances, in addition to inflammation, play a part in the abnormal accumulation of fat in the tissues of the appendix, particularly as bends, kinks, twists and adhesions are so common in this type of appendicitis. Impairment of circulation under experimental conditions has been found to contribute to abnormal formation of fat in the tissue involved. According to Fischler [10] this has been found to be the case in the margins or edges of infarctions where circulation is impaired yet where tissues are still viable. Dietrich [11] noted the appearance of fat in tissues implanted into the peritoneal cavity. The characteristic "tigering" of the heart seen at autopsies when the heart is the site of fatty degeneration is usually attributed to impairment in circulation.

In acute suppurative or gangrenous appendicitis, of which 85 specimens were examined, visible fat plays a less conspicuous part in the lesion. It is not infrequently the case, especially in gangrenous appendicitis, that small areas of the wall of the appendix take on a dull orange color when stained

with Sudan. Such orange zones are found in any part of the wall, and microscopically the tissues comprising these zones show a granular light yellow stain. These areas probably represent fat phanerosis in necrobiotic or autolytic regions. Where an acute condition is grafted on a chronic process, fat is present and shows a distribution such as that already described above for chronic appendicitis.

SUMMARY

The larger folds of the stomach, the pylorus, the ileocæcal valve, the large intestine and the appendix contain normally moderate amounts of fat in the submucosa. Fat in the appendix makes its appearance after birth.

Chronic inflammation of the appendix may be associated with or without an increase of visible fat. In about 14 per cent. of appendices examined which were chronically inflamed fat was very much increased and affected occasionally the muscular coat as well as the submucosa.

Abnormal accumulation of fat in the appendix is induced by inflammation, aided probably by impairment of circulation in the wall of the appendix.

REFERENCES

[1] Rosenfeld, G.: Fettbildung. Ergebnisse d. Physiologie, 1902, 1, 651.

[2] Kawamura, R.: Die Cholesterinester verfettung. Jena, 1911, 93.

[3] Wells, H. G.: Chemical Pathology, 1914, 363.

[4] Aschoff, L.: Zur Morphologie der lipoiden Substanzen. Beitrage zur Path. Anat. u. allgemein Path., 1910, 47, 1.

[5] Wolfer: Quoted by Zuckerkandle, E. See below.

[6] Zuckerkandle, E.: Ueber die Obliteration des Wurmfortsatzes beim Menschen Anatomische Hefte 1894, 4, 99.

[7] Suduski: Beitrage zur normalen und pathogischen Anatomie des Wurmfortsatzes. Mittheil. a. d. Grenzgeb. d. Med. u. Chir., 1901, 7, 516.

[8] Smith, Geo. M.: Inflammatory Changes in the Appendix during Early Infancy. American Journ. of Children's Diseases. 1911, 1, 299–309.

[9] MacCarthy: Journ. Am. Med. Assn., 1910, lv, 488.

[10] Fischler, F. J.: Ueber den Fettgehalt in Niereninfarkten, zugleich ein Beitrag zur Frage der Fettdegeneration. Central. f. Allg. Path. u. Path. Anat., 1902, 13, 417.

[11] Dietrich. A.: Experimente uber Fettbildung. Verhand. d. Deutsch. Path. Gesellschaft, 1915, 9, 212.

SPONTANEOUS PAN-HYSTERECTOMY AFTER ABDOMINAL CONTUSION

By Louis Fleming Fallon, M.D.

of the St. Anthony Clinic, North New Foundland

The following case seems worthy of record:

April 21, 1917: A. L., white female, aged twenty-nine years, living in poor surroundings. She has been married ten years, has had five children, all living. No miscarriages nor stillbirths. Patient gives a history of always having been strong and healthy. She has had no serious illness in her life.

About the middle of March, at which time the patient considered herself two months pregnant, she was knocked down by a partly filled molasses barrel falling against her. Beyond bruising she apparently suffered no injury.

April 13 she "found herself beginning to flood." This continued the next day and was accompanied by severe abdominal pain. Bleeding lessened somewhat the next day but the abdomen continued very tender. A midwife was called in that evening.

The next day, April 16, the patient was unable to void urine "because something seemed to be pressing against the opening."

The midwife gently pressed down over the bladder (resembling Credé manœuvre?) and a mass was expelled through the vagina "looking like a baby's head" but hanging by a few shreds of tissue. The midwife called in another woman, as the mass did not "come away." Moderate bleeding continued. The shreds were cut and the mass removed. At that time the abdomen was so tender that the patient could not bear to be moved or touched. Bleeding stopped April 17. A doctor had been sent for, as they despaired of the woman's life. In the two days necessarily intervening before my arrival the patient had begun to get better.

Physical examination showed an adult, fully developed, moderately nourished female lying comfortably in bed with cheeks slightly flushed. The temperature was 100.5°, pulse 96 and the respirations 24. Heart and lungs were normal. Pulse was good quality. The abdomen was moderately distended with some rigidity low down. There was tenderness above the pubes and a tender mass palpable low down in the right iliac fossa. The rest of the abdomen was but slightly tender. The patient could be moved about the bed without complaining of any pain and was put in lithotomy position.

On examination there was a gangrenous mass protruding through the vulva which proved to be omentum. The uterus was absent from position and its place occupied by a mass most prominent in the right vault. No loop of intestine was incarcerated in the vagina. There was a moderate purulent discharge.

FIG. 1.—Uterus with appendages viewed anteriorly.

FIG. 2.—Posterior view. Pins have been placed in openings of uterine vessels.

The sloughing omentum was tied off as far up in the vagina as possible. A daily douche of hot perchloride 1 : 4000 was instituted. The patient was put in the Fowler position and on liquid diet. She had morphia gr. ¼ hypo.

April 21 : Temperature was 100°, pulse 96 and good quality. Patient had a comfortable night and was in good condition, asking to be given solid food. She was voiding without pain, but the bowels had not moved since her illness began.

May 26: "The following word was received, "Patient got up on April 30, for first time, and began to get about a week ago. She feels fine. There is no pain. She is able to do her work now."

The specimen shown readily explains itself. It had been split anteriorly for examination. The line of separation seems to follow almost the lines of the usual pan-hysterectomy except that it includes more of the broad and the whole of the round ligaments. There are also both tubes, the left ovary, the complete uterus and part of the vagina. The specimen is represented in Figs. 1 and 2 from drawings by Dr. Wilfred T. Grenfell, to whom I am gratefully indebted for his interest and kindness in making them. He has purposely made them somewhat diagrammatic, but correct as to size and relations. The specimen, having been in formalin, was decolorized, and Dr. Grenfell has supplied the color by description. The location of the uterine vessels is shown by some of the pins which were used in mounting the specimen.

INTESTINAL OBSTRUCTION: AN EXPERIMENTAL STUDY

By Barney Brooks, M.D.
of St. Louis, Mo.
with the collaboration of
Harry W. Schumacher and John E. Wattenberg

(From the Department of Surgery, Washington University Medical School, St. Louis, Missouri)

The experiments described in this paper were carried out for the purpose of obtaining material for a study of the chemical nature of the toxins formed as a result of intestinal obstruction. The experiments, however, illustrate some important facts bearing on the problems of intestinal obstruction independent of the chemical nature of the toxic substances formed.

Murphy and Vincent [1] have shown from experiments on cats that the interference with the blood supply to loops of obstructed bowel is a very important factor in bringing about early severe symptoms and death in the experimental animals. They showed that following the obstruction and strangulation of a loop of bowel the animal showed signs of very grave intoxication in 4–6 hours. Hartwell and Hoguet [2] have shown that the severity and rapidity of development of symptoms is in direct ratio to the extent of damage to the mucosa of the obstructed bowel. Whipple, Stone and Bernheim [3] found that isolated obstructed loops of jejunum caused death in 72–76 hours. They state that it is possible for the animal to die as a result of intestinal obstruction without there being demonstrable abnormality of the mucosa of the obstructed loop. They believe that in such instances there is absorption of the toxic substance directly from the mucosa and not from the lumen of the obstructed bowel. Murphy and Brooks [4] called attention to the fact that in a study of the intoxication following intestinal obstruction it was essential to differentiate clearly two factors, viz., the production of the toxic substance, and the absorption of the toxic substance. It was stated that the latter was the more vital factor. It was demonstrated that the toxin was of bacterial origin and was not absorbed by the normal intestinal mucosa. These observers believed that the most essential factor in determining the absorption of the toxin from the obstructed loop of bowel was a disturbance in the nutrition of the mucosa as a result of strangulation or rapid distention of the bowel.

Dragstedt, Moorehead and Burcky [5] have shown that sterile isolated obstructed loops of bowel cause no intoxication even if such loops perforate and discharge the contents into the peritoneal cavity. If, however, the isolated obstructed loops contained bacteria and if there was tissue necrosis, the animals showed signs of intoxication. The authors emphasize the importance of the tissue necrosis but do not state clearly whether they believe the

necrosis of tissue is a factor in the production of the toxin or in the absorption of the toxin.

The following described experiments were carried out on dogs: Only three experiments will be described. These experiments have been repeated many times in connection with other experimental studies with constant results. The operations were always done under complete surgical anæsthesia, and the usual surgical aseptic precautions were carefully observed. Every effort was made to prevent pain and suffering in the experimental animals. When the animals did not die as a result of the experiment they were sacrificed by the administration of chloroform.

EXPERIMENT No. 1.—Dog. Weight 10.8 K. April 4, 1917. 10 A.M.

Ether anæsthesia. Laparotomy. Tape tied about highest portion of jejunum. Another tape was tied about the ileum. Approximately 100 cm. of bowel occluded between tapes. All of the veins in the mesentery of the occluded bowel were ligated. Abdomen closed.

Seven hours: Animal is desperately sick. Vomiting. No stools.

Twenty-one hours: Animal found dead. Occluded loop very much distended. The loop content consisted of 330 c.c. of thick bloody fluid of foul odor; the bowel wall was swollen and hemorrhagic. The mucous membrane was completely destroyed.

Thirty c.c. of the loop content injected intravenously into a healthy dog weighing 6 K. caused death in 8 hours. Autopsy of the injected animal showed the mucosa of the duodenum and jejunum swollen and red.

Other animals which received intravenous injections of smaller amounts of the loop content showed symptoms but did not die.

EXPERIMENT No. 2.—Dog. Weight 18 K. April 16, 1917.

Ether anæsthesia. Laparotomy. The jejunum was sectioned as high as possible. Both ends of the sectioned bowel were turned in. The bowel was sectioned again 40 cm. distal to the previous section. Both ends turned in. Lateral anastomosis between the proximal and distal stumps. Abdomen closed.

This operation gave an isolated occluded loop of jejunum 40 cm. long. Special care was taken in turning in the ends of the isolated segment. Only a very small amount of bowel wall was inverted.

One day: The animal is up.

Two days: Dog is up. Eats. Does not look sick. No vomiting.

Six days: Animal eats. Seems rather drowsy. No vomiting.

Seven days: Animal looks drowsy. Weight 13.6 K. Anæsthetized. Abdomen opened. Isolated loop found completely closed. Markedly distended. Bowel wall showed no evidence of necrosis. The distended isolated loop was excised. The abdomen was closed. The animal ultimately completely recovered.

The isolated obstructed loop contained 350 c.c. of a thick, gray colored material. The mucosa appeared rather more opaque than normal. It was, however, quite smooth and velvety. There was a small ulcerating spot at either end where the bowel had been turned in. Otherwise the bowel wall seemed quite normal.

Three c.c. of the loop content was diluted with 7 c.c. of sterile water and given intravenously to a dog weighing 5 K. The injection was followed by frequent vomiting, passage of bloody stools, collapse and death in 3 hours. Autopsy of the animal injected showed a marked hemorrhagic mucosa of the duodenum and jejunum and the entire lumen of the bowel was filled with bloody mucous material.

EXPERIMENT No. 3.—Dog. Weight, 10.8 K. April 21, 1917.

Ether anæsthesia. Laparotomy. A loop of jejunum 80 cm. in length was isolated and the ends very carefully turned in so as to invert the least possible amount of

bowel wall. The continuity of the intestinal tract was re-established by lateral anastomosis between the proximal and distal stumps of bowel. Abdomen closed.

Two days: Animal is up. Seems quite well.

Fifteen days: The animal is losing weight. Eats well. No vomiting.

Twenty-one days: For the past week the animal has seemed somewhat drowsy. Eats well.

Weight 7.2 K. No vomiting. Does not seem particularly sick. Sacrificed.

Autopsy showed the isolated loop completely closed. It was markedly distended. The intestinal anastomosis was healed. The peritoneal cavity appeared quite normal. The bowel wall shows nothing abnormal on the peritoneal surface (Fig. 1). The content consisted of 400 c.c. of a thick gray material of very foul odor. The mucosa of the occluded loop was opaque white in color. It was smooth and velvety. There were a few small irregular hemorrhagic areas, suggesting beginning necrosis in the bowel wall. There was complete healing of the inverted ends. Microscopic sections of several areas in bowel wall showed some infiltration of the tissue with lymphocytes. The tips of the villi were œdematous. The epithelial cells were absent from the tips of the villi. The epithelium of the deeper glands seemed normal.

Two c.c. of the loop content was injected intravenously into a dog weighing 7.2 K. After the injection the animal vomited frequently, passed bloody stools, showed extreme collapse, and died in 7 hours. Autopsy showed a very marked hemorrhagic mucosa of the duodenum and jejunum. The lumen of the entire length of the bowel was filled with a blood-stained mucous material.

These experiments illustrate some facts which should be thoroughly appreciated by the clinical surgeon and the laboratory worker who is concerned with the problems of intestinal obstruction.

In Experiment No. 1, in which there was extensive damage to the bowel wall from venous stasis, the animal died in less than 21 hours. The content of the obstructed loop consisted of 330 c.c. of material of which 30 c.c. represented a lethal dose for a 6 K. dog when it was given intravenously. That is, the entire loop contained at death only about 10 lethal doses for a 5–6 K. dog. In Experiment No. 2, in which there was a simple obstruction of an isolated loop of jejunum and in which special care was taken not to expose areas of damaged mucosa to the possibility of absorption of the loop content, the animal lived for 7 days without showing signs of severe intoxication, and then made a complete recovery after the excision of the isolated occluded loop which contained at least 115 times the amount of toxic material necessary to kill a 5 K. dog in 3 hours, when given intravenously. During the last day of this experiment the animal was beginning to show signs of absorption of the toxic loop content, manifest by the continuous drowsiness. This was the result of the distention of the occluded loop to point at which there was beginning nutritional change in the mucous membrane and a beginning impairment of its normal selective absorptive power.

Murphy and Brooks [4] called attention to the fact that simple obstruction of segments of upper jejunum resulted in earlier symptoms and death than similar obstruction of loops of ileum because the "higher" loops became more rapidly distended from the greater amount of secretion of fluids into the lumen of the bowel, and consequently more rapid nutritional change in the mucous membrane. In Experiment No. 3, a relatively long loop of bowel

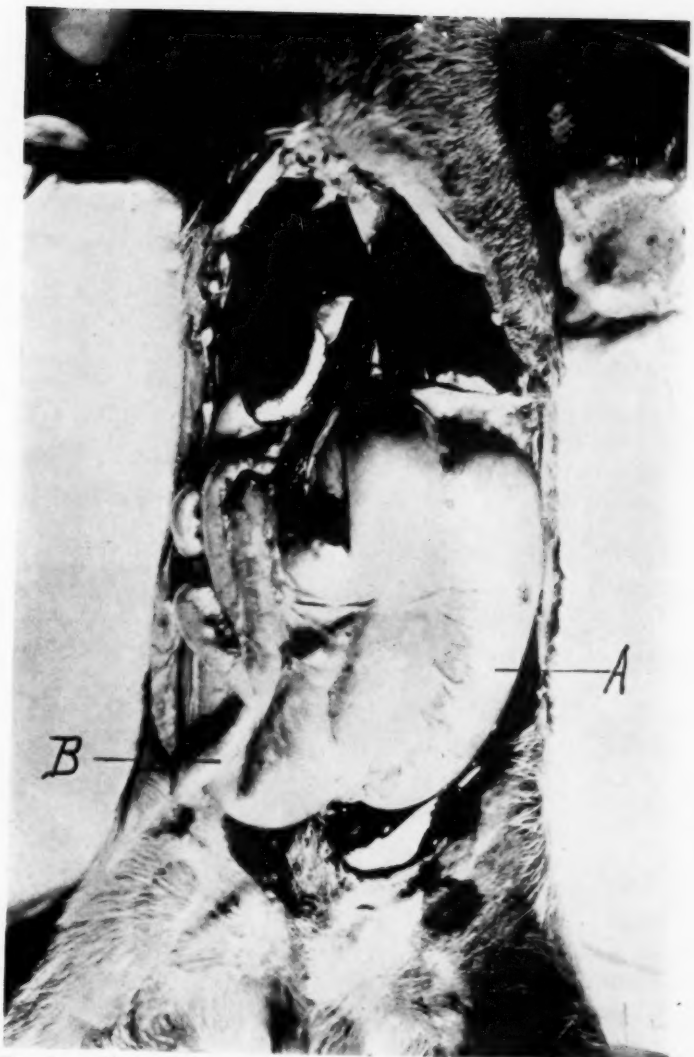


FIG. 1.—Experiment No. 3. Photograph showing the distended, isolated, obstructed loop of bowel of twenty-one days' duration. *A*, distended isolated loop; *B*, intestine which was not obstructed.

was isolated and occluded. In such a loop there is probably a sort of a balance between the excess of secretion of fluid into the lumen of the proximal end and the excess of absorption of fluids from the lumen of the distal end. In this experiment the dog was sacrificed at the end of 21 days and the animal was at this time only beginning to show signs of absorption of the toxic loop content. The occluded loop contained 400 c.c. of material, 2 c.c. of which injected intravenously into a healthy dog weighing 7.2 K. caused death in 7 hours.

These experiments show the importance of distinguishing clearly between the two factors, production of toxin, and absorption of toxin. In Experiment No. 1, in which there was the maximum of opportunity for absorption of the toxic loop content, death resulted before the loop content had attained a high degree of toxicity. In Experiment No. 3, in which there was little damage to the mucosa from the operative procedure and in which the occluded loop distended slowly and there was little nutritional change in the mucosa, the animal showed relatively little evidence of intoxication at the end of 21 days, although there was produced in the occluded loop two hundred lethal doses of the toxic substance if given into the circulation. In Experiment No. 2, in which the loop was relatively shorter and higher and in which distention of the bowel and absorption of the toxic substance developed more rapidly, there was an earlier appearance of symptoms. Whipple, Stone, and Bernheim,[3] and Murphy and Brooks [4] have shown in many experiments that short high occluded loops of jejunum, in which special care has not been taken in turning in the ends of the bowel, distend rapidly and result in death in 72–96 hours.

That the failure to develop symptoms in these instances of simple obstruction of loops for long periods is not a result of the animals developing immunity has been proven by Dragstedt, Moorehead, and Burcky,[5] who have shown that symptoms and death rapidly follow the ligation of the veins of such loops. We have also found that an animal having an isolated occluded loop of several days' duration has no demonstrable immunity to the toxic loop content if given intravenously.

In Experiment Nos. 2 and 3, there was no necrosis of tissue and yet there was in each case production of a large quantity of highly toxic loop content. It can not be denied that necrosis of tissue may increase the rapidity of formation of the toxin, but actual visible tissue necrosis is not necessary to the production of a very toxic loop content. It seems more probable that necrosis of the bowel is more a factor in bringing about the absorption of toxin than in its production.

It is interesting to note that in some experimental work which is as yet not published it has been found that an isolated occluded loop of bowel of several days' duration will absorb glucose readily at same time that it contains a large quantity of very toxic material which is not absorbed.

These experiments also illustrate another fact which has been previously mentioned in the reports of the experimental work of Hartwell and Hoguet,[2]

Whipple, Stone, and Bernheim,[3] Murphy and Brooks,[4] and Dragstedt, Moorehead and Burcky,[5] but which has never been appreciated by a large number of clinical surgeons. This fact is as follows: *The toxic substance produced in the lumen of obstructed bowel is not absorbed by the normal intestinal mucosa.* The belief that the acute symptoms of intoxication which may follow the relief of an intestinal obstruction are due to the absorption of the toxins of the obstructed bowel after the toxic fluid has passed into the normal bowel distal to the obstruction, is disproved by these and many other experiments. That a patient may grow rapidly worse immediately after the release of an intestinal obstruction cannot be denied, but the reason for this is not that the normal bowel distal to the obstruction absorbs the toxic substance after it is passed through the point of previous obstruction. There are other explanations which are not contradictory to experimental work. It may be in such instances that the operative measures damage the mucosa at some point, *e.g.*, an intestinal anastomosis, and thus permit a more rapid absorption of the toxins already formed. In case of strangulation or volvulus it may be that the operative relief of the obstruction to the blood- or lymph-vessels permits a more rapid absorption of the toxic loop content from the already damaged mucosa. Or it may be the patient has already absorbed a lethal or near lethal dose of the toxic substance before the operative procedure is undertaken. In which case, the operation is merely an incident in hastening the onset of the fatal or near fatal condition from its general effects rather than from any effect on the subsequent absorption of the toxins. The last is probably most often true.

The method described in Experiment No. 3 is of particular value to the laboratory worker who is interested in the study of the chemical nature of the toxins of intestinal obstruction. It permits of the collection from a single animal of a large quantity of highly toxic loop content. From such a loop a large quantity of the toxic proteose-like substance which has been described by Whipple[6] may be easily obtained. Certain differences in the chemical nature of the toxic substances of obstructed loops of different periods of duration, which seem to indicate the manner of formation of these toxins, will be reported in a later paper.

BIBLIOGRAPHY

[1] Murphy and Vincent: Boston Med. and Surg. Jour., 1911, clxv, 684.
[3] Hartwell and Hoguet: Amer. Jour. Med. Sc., 1912, cxliii, 357.
[3] Whipple, Stone, and Bernheim: Jour. Exp. Med., 1913, xvii, 286; 1913, xvii, 307; 1914, xix, 144; 1914, xix, 166.
[4] Murphy and Brooks: Arch. Int. Med., 1915, xv, 392.
[5] Dragstedt, Moorehead, and Burcky: Jour. Exp. Med., 1917, xxv, 421.
[6] Whipple: Jour. Amer. Med. Ass., 1915, lxv, 476.

THE ETIOLOGICAL RELATIONSHIP OF BENIGN ULCER TO CARCINOMA OF THE STOMACH*

By Abraham O. Wilensky, M.D.
and
William Thalhimer, M.D.
of New York

(From the Surgical Service of Dr. A. A. Berg and the Pathological Laboratory of Mount Sinai Hospital.)

INTRODUCTION

Defects of the gastric mucosa are frequently found in conjunction with gastric carcinoma, but the etiological relationship of benign ulcers of the stomach to gastric carcinoma is as yet an unsettled question. In the following investigation we have tried to ascertain whether a microscopical study of a series of benign and malignant ulcerations of the stomach would throw any added light upon this subject.

Certain difficulties were encountered which we believe are inherent in such a morphological study, and which have also been noted by other observers. There is at present a complete lack of experimental means available for this investigation. None of the animals, domestic or wild, are susceptible to spontaneous chronic gastric ulcers, and for this reason, in all probability, no satisfactory method has been found to consistently produce chronic gastric ulcers in animals so that the course of these ulcers can be studied.

At present the only criteria we have for determining if a gastric ulcer develops into a carcinoma are based on microscopical evidence.

DEFINITION OF TERMS

A number of terms will be continuously employed throughout this paper and for the purpose of clarity are herewith defined:

Ulcer.—Solutions of surface continuity extending to a varying depth and showing no evidence of carcinomatous structure; employed in the commonly accepted usage as indicating a defect which shows no tendency to heal.

Carcinoma.—Tumor formations of a carcinomatous nature with the surface continuity unbroken. These include cauliflower-like tumors with sessile or pedunculated bases and diffuse infiltrations of the stomach wall.

Ulcerated Carcinoma.—Tumor formations in which defects have occurred but in which the gross appearance of tumor formation is present and evident.

Ulcer-like Carcinomatous Lesions.—Defects having the gross appearances of benign ulcerations but in which the total structure is demonstrated microscopically to be composed of carcinomatous tissue.

Mixed Lesions.—Defects resembling in all gross characteristics the appearance of ulcers (as above defined) but in which at one or more points of the periphery there are areas composed of definite carcinomatous tissue.

* This study was carried on under the tenure of a Moses Heineman Fellowship.

MATERIAL STUDIED

Gastric Ulcers.—Thirty-eight typical chronic gastric ulcers were examined. These presented the typical gross and microscopical appearances which characterize a chronic gastric ulcer. The variations found in these lesions were all within the usual limits and none showed any definite indication of malignancy.

Microscopical Studies.—Microscopical examination reveals a great similarity in the pathological processes in the majority of the specimens. All the ulcers show certain prominent characteristics. The edge of the ulcer is sharp, as though cut off, even when it is overhanging. The mucosa at the edge shows only a superficial degeneration and a moderate grade of chronic inflammation consisting of congestion, œdema and diffuse infiltration with mononuclear leucocytes, plasma cells and a few polymorphonuclear leucocytes. The glandular structures at the edge of the ulcer show slight degenerative changes of their cells. Some of the glandular acini or crypts have the appearance of being cut off and do not reach the surface of the mucosa but terminate at the edge of the ulcer. Whenever found, the cells of the acini are contained within their basement membrane but show a tndency in some specimens to a moderate hyperplasia.

In the main the hyperplasia consisted of glands which were more tortuous than normal, sometimes with cystic-like dilatation. In places these cells of the acini were piled one upon the other. It is hard to differentiate, however, the appearance of piled-up cells from the appearance presented by glandular acini where the section has been made tangential to the periphery of the gland. There was always a tendency in the piled-up cells for the nuclei to remain at one end of the cell and not to approach the centre. These nuclei were also practically normal in appearance and did not have the dark staining, dense qualities which nuclei of carcinomatous cells have. The lining, *i.e.*, the surface of the ulcer, consists of a narrow layer from one-eighth to one-third the diameter of a low-power field of the microscope in thickness and is made up of degenerating and necrotic fibrous tissue. The layer of degenerating tissue fuses with or is transformed into dense fibrous tissue, although the line of demarcation is clearly seen. The fibrous tissue extends for a considerable distance, in places as much as 1 cm., into the submucosa and muscularis. It has the typical characteristics of scar tissue and seems to form a wall beneath the ulcer. Some of the ulcers have completely penetrated the stomach wall, but the edges are always covered by the above structures and the bare muscularis is never exposed. The connective-tissue septa, which lie between the muscle bundles and are accompanied by blood-vessels, are increased in size by fibrous tissue and dense infiltration with mononuclear leucocytes. Similar areas of fibrosis and infiltration are found beneath and in the serosa.

Occasionally, but only rarely, prolongations of the degenerating surface layer, several millimetres in size, are found in the dense fibrous tissue layer, but these are always completely limited by the latter.

In a few of the specimens the diagnosis of ulcer was arrived at with considerable difficulty because of atypical hyperplastic forms at the edge. The reasons of this will be given at length under the heading of " discussion."

Gastrojejunal Ulcers.—Five specimens were studied and showed the typical gross and microscopical appearances of chronic gastric ulcer with the additional factor, probably due to location, of a greater degree of fibrosis about them and a greater redness of the serosa in the neighborhood, indicating acute and subacute inflammatory changes. One of these specimens is of especial interest, inasmuch as the ulcer recurred at a second gastrojejunostomy which was performed at the same site after the first gastrojejunal ulcer had been resected. Four of these occurred after a posterior no-loop gastrojejunostomy, three by the suture method and one by the Murphy button. One occurred after an anterior suture gastrojejunostomy. In none of these was Pagenstecher thread found projecting from the ulcer, although in three of the operations Pagenstecher was used in the outside serosa suture of the anastomosis. This is important, as apparently linen thread suture material had nothing to do with the etiology of these ulcers. This is also demonstrated by the ulcer which occurred after the Murphy button gastrojejunostomy. The same degree of hyperplasia was found microscopically as was present in the chronic gastric ulcers, but no indications of malignancy were present.

Healed Gastric Ulcers.—Two specimens were studied. In both the healed ulcers were situated over the lesser curvature of the pyloric antrum. In one the glands had undergone a marked cystic dilatation; in the other compressed and atrophic glandular acini were found in the midst of the scar tissue at the level of the muscularis. In neither were any signs of carcinoma present.

Ulcer-like Carcinomatous Lesions.—Seven specimens were studied. These constituted a very interesting group. Grossly these lesions could not be differentiated from chronic gastric ulcers. In several, however, malignancy was suspected, but in the remainder we were very much surprised to discover, on microscopical examination, that the defect showed an infiltrating carcinoma extending around the entire edge and into the base of the ulcer and the stomach wall around it.

There is one additional specimen which belongs to this group which was discovered at autopsy. This patient had a general carcinomatosis with a most extensive intra-abdominal and retroperitoneal involvement. The primary tumor proved to be a carcinoma of the lesser curvature of the stomach, which grossly had the appearance of a gastric ulcer and appeared insignificant compared to the metastases which had emanated from it. The remainder of the stomach showed malignant involvement of the lymph-nodes on both curvatures, but the wall was soft and normal in appearance. Microscopically, however, a network of malignant cells were found everywhere in the lymphatics throughout the serosa.

Carcinoma.—The study of the structure of many specimens of frank

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Carcinoma.—The study of the structure of many specimens of frank

carcinoma of the stomach added nothing to the solution of the problem under discussion and descriptions of these lesions will not be included here.

Chronic Gastric Ulcer with Carcinomatous Involvement of Regional Lymphnodes (One Specimen Studied).—This lesion presented a typical appearance of a chronic gastric ulcer. Microscopical sections were made of practically the entire lesion. Carcinoma was not found in any of these sections. The ulcer was situated on the lesser curvature, 4 cm. from the cardiac orifice of the stomach. At operation palpation of the cardiac orifice and lower portion of the œsophagus failed to reveal a neoplasm.

A detailed description of this specimen follows:

SPECIMEN "U" (Fig. 17).—*Macroscopical.*—The specimen (5 × 6 cm.) consists of a portion of the stomach measuring six centimetres along the lesser curvature.

Two centimetres from the cardiac end of the specimen and situated at the lesser curvature is a deep, oval, punched-out ulcer, 1.5 × 1.2 cm. in size and 1 cm. in depth. The edge is sharp cut, but the mucosa at the other end is slightly overhanging. The lining is pinkish gray in color, apparently consisting of granulations. The ulcer seems to extend through all the coats of the stomach and for a slight distance into the gastrohepatic omentum. The remainder of the gastric mucosa is slightly reddened, but otherwise normal. In the gastrohepatic omentum which has been resected are a number of lymphnodes about one centimetre in diameter which are slightly firmer than normal. On section the lymphnodes are succulent, translucent and pinkish gray in color. One lymphnode was removed separately, about 1.5 × 2 cm. in size, and is slightly firmer than the others. Its centre is broken down, forming a small irregular cavity.

On section through its centre, the ulcer is found to have penetrated all the coats of the stomach into the gastrohepatic omentum. Radiating from the base into the tissue about it are firm, fibrous bands, giving the cut surface a fan-like appearance.

Microscopical.—The sections show a typical indurated ulcer. The edges are sharp and the mucosa is not overhanging. About one centimetre away from the edge of the ulcer there are found a few deep reaching glands of the mucosa extending slightly beyond the remainder of the mucosa in the midst of the muscularis mucosa. These glands, however, are perfectly normal in appearance. There is no sign of any attempt at malignant transformation at any place. The ulcer is lined by the usual type of degenerating material, and here and there with the Gram Weigert stain, in and upon the degenerating lining, a moderate number of cocci, large and small bacilli and yeasts are found. None are found in the depths.

Lymphnode from lesser curvature: Structure is almost entirely replaced by malignant tumor which has the appearance of a squamous cell carcinoma, including pearl formation.

Another lymphnode shows chronic inflammation and fibrosis. No bacteria are seen with the Gram Weigert stain.

Carcinoma Occurring in an Apparent Chronic Gastric Ulcer.—A detailed description of one specimen in the group follows:

SPECIMEN "W" (Figs. 9–14) (See Photograph for Diagram of Blocks Studied).—*Macroscopical.*—The specimen consists of the pyloric antrum. In the middle of the lesser curvature of the specimen is an indurated area, about three to four centimetres in size. On opening the stomach, beneath this indurated area, a saddle shaped ulcer is found, four by one and one-half centimetres in size, reaching down from the lesser curvature on to both anterior and posterior walls of the

stomach. The edge of the ulcer is raised and its mucosa is reddened. The ulcer is deep and sharp cut, and varies in depth from four millimetres to one centimetre. The edge of the ulcer nearest the cardia is definitely overhanging. Just to the pyloric side of the ulcer, about two millimetres from its edge, is a round, superficial ulceration, one centimetre in width. The ulcer proper reaches through the muscularis and extends into the serosa and to a certain extent into the gastrohepatic omentum. The edge of the ulcer is rather firm in consistency, but does not have the appearance of new growth. The remainder of the mucosa is somewhat reddened. No other ulcerations are found. The lymphnodes over the lesser curvature are somewhat enlarged.

On section the ulcer is found to have penetrated through all the coats of the stomach and the base of the ulcer is surrounded by a layer of dense, fibrous tissue, about one-half centimetre in width. Immediately beneath the small superficial ulcer area described above and near the edge of the ulcer, a round area which is somewhat translucent, having the appearance of either a lymphnode or an isolated piece of muscularis, is found.

Microscopical.—Section 1: Section is that of an ulcer-like lesion. The defect has the typical outline of an ulcer. The mucosa at its very edge is extremely atypical, composed of solid columns of cells apparently extending into the interstitial tissue, having the appearance of early malignancy. Immediately next to this at the edge of the atypical mucosa is a fairly well demarcated, rounded area of medullary colloid carcinoma which has definitely infiltrated the submucosa. The mucosa farther on beyond the colloid area and farther away from the edge of the ulcer is fairly normal except for slight inflammatory changes and hyperplasia of some glands.

Section 2: Shows portion of the base of an ulcer which has the appearance of a chronic ulcer. The tissue beneath this is fibrous and adipose, showing inflammatory changes.

Section 3: Shows a lesion with the typical outline of chronic gastric ulcer with an overhanging edge. The glands at the exact edge show the usual type of inflammatory and hyperplastic processes seen in gastric ulcers. A very short distance beyond this, however, over an area about the width of the low power field of the microscope, the superficial glands are extremely atypical in appearance. They are definitely invading the interstitial tissue, and are made up of irregularly arranged cells, the nuclei of which are dark staining, are situated approximately at the centre of the cell and show a moderate number of mitotic figures. This area is definitely carcinomatous and in places one portion of the gland appears to be normal and the other portion carcinomatous. The small area of mucosa between this and the edge of the defect shows the usual regenerative processes seen in gastric ulcer but is not carcinomatous. The remainder of the mucosa shows slight inflammatory changes only. .

Section 4: Consists of a portion of stomach wall covered by practically normal mucosa showing slight inflammatory changes.

Section 5: Edge of ulcer. The base of the defect has the typical appearance of that of a chronic ulcer. The mucosa at the edge and for quite a distance away shows a typical adenocarcinoma of the type usually found in the stomach. This carcinomatous area is quite sharply demarcated from the normal mucosa which makes up the remainder of the section.

Section 6: The section is that of a portion of the base of the defect which has the appearance of a chronic ulcer.

Section 7: The edge of the defect has the appearance of that of a chronic ulcer. The mucosa at the very edge shows an atypical appearance of its glands with an extreme degree of hyperplasia. The cells are confined within the basement membrane and therefore no carcinoma is present in this section.

Section 8: Consists of an ulcer-like lesion. The base of this lesion has the appearance of that of a chronic gastric ulcer. At the very edge of this lesion is a small nodule of typical colloid carcinoma. Immediately beyond this for quite a distance the mucosa is replaced by a typical adenocarcinoma. This latter stops rather abruptly, but seems to merge with the normal mucosa which makes up the rest of the section.

Gram Weigert Stain: A careful search was made of all of the above described sections stained with the Gram Weigert stain and in only one of them a small collection of cocci was found upon the surface. No organisms were found in the depth.

Specimen "W" showed in several sections no carcinoma. We believe this specimen satisfies all the requirements laid down by Stromeyer to prove that a carcinoma can develop in a gastric ulcer.

DISCUSSION

In the light of the preceding gross and microscopical descriptions of the lesions studied it is seen that the material consists of:

1. Specimens in which there is no doubt as to whether the lesion is benign or malignant.

2. A specimen in which a part of the lesion is definitely benign and other parts are definitely malignant.

3. A few specimens in which the diagnosis is arrived at with difficulty.

The diagnosis in these latter cases (Group 3) is always a matter of personal opinion based on accumulated experience. The matter becomes all the more difficult when one considers the work of Bullock, who has shown that under the influence of chronic irritation it is possible to produce lesions in epithelial structures which resemble malignant tissue microscopically. Yet a removal of the source of irritation is promptly followed by a regression and disappearance of the suspicious structures. This experimental work applies in the human cases in those border line lesions in which one must distinguish between hyperplastic forms in the edge of the defect and an early malignant transformation. In a certain number of the cases the microscopical appearance of the lymphnodes draining the infected area can give deciding information, for the presence of metastatic carcinoma in these furnishes a ready and accurate method of differentiation. This is well illustrated by specimen 26, a description of which follows:

Macroscopical.—The specimen consists of the entire antrum. Immediately beneath the lesser curvature in the middle of the specimen there is an irregular deep ulcer about one and one-half centimetres in width. The edge is somewhat undermined and along the edge are numerous irregular red elevations. The base is gray in color. Extending from the ulcer in an irregular fashion towards the greater curvature are two more superficial ulcerations which are serpiginous in character. One of these is about 1 × 2 cm. and the other is 1 × 3 cm. in size.

Microscopical.—The sections are from several portions of irregular ulcerations. In general the picture presented is that of chronic ulcer, in addition to which, however, a very peculiar proliferative process in the mucosa is present, which in several places is definitely malignant even though it is a very early stage of malignancy. At the edge of the ulcer-like process the glands of the mucosa show an extreme hyperplasia.

Many of these glands, although they retain practically their normal shape, are made up of irregularly arranged cells, the protoplasm of which stains a deeper red than normal and the nuclei of which are irregular in position and shape, many of them being larger than normal and all of them staining a deeper blue than normal. In the depth of the ulcerated portion of the mucosa at the edge of the ulcer, the glands can be traced into irregular projecting columns of the epithelial cells which generally are situated in the midst of connective-tissue stroma. The base of the defect shows over its middle portion no mucosa, but degenerated fibrous tissue upon a fibrous tissue foundation. The hyperplastic glands near the edge, however, extend for a considerable distance upon the sides of the base of the ulcer and some of these glands present a picture of an early carcinoma, whereas others are practically normal in appearance. The base of the ulcer, where these glands are present, is covered by an almost continuous line of epithelium which is almost normal in appearance, but here and there these cells resemble the malignant cells describd above.

A lymphnode from the lesser curvature is situated immediately beneath the ulcer-like lesion and shows in the lymph sinuses at the periphery of one end groups of carcinoma cells, with no adenomatous arrangement.

As a general rule we believe it may be stated that, when the microscopical picture is of such a nature as to give rise to doubt, in all probability the atypical forms are hyperplastic and not malignant. There is no adequate laboratory method available at present for proving this point absolutely. These lesions have therefore been classified by us as ulcers.

Latterly the etiological relationship between carcinoma and ulcer has received much attention and the belief has gained ground that carcinomatous transformation of a benign ulcer takes place very frequently. Stromeyer had described morphological criteria for judging the etiological relationship between ulcer and carcinoma. These criteria are in substance as follows:

When the defect is surrounded completely, both in the base and on the periphery by malignant tissue and the latter extends deepest at a point corresponding to the centre of the base of the defect, the lesion is a primary carcinoma upon which a defect has been superimplanted. When an ulcer has a base which is entirely free of tumor tissue and the periphery shows only at one point atypical carcinomatous forms, an opinion may be entertained that carcinoma has become implanted on a preëxisting ulcer.

In any event we believe that a judgment must be made with the following limitations:

1. The observation is made at one stage of the development and the picture obtained gives no clue as to (*a*) the age of the lesion; (*b*) the preceding condition, especially at the inception; and (*c*) in benign lesions, the final outcome if the lesions had been undisturbed.

2. Normal growth, hyperplasia, and malignancy make use of the same underlying laws which govern the growth of tissue, and of necessity instances will often occur in which the differentiation between hyperplasia and malignancy becomes a matter of great difficulty.

3. The amount of necrosis which so frequently occurs in malignant tumors. The importance of this element becomes apparent on referring to the accompanying diagrams:

FIG. 1: The amount of necrosis is at a minimum. The defect is then entirely surrounded both on the periphery and in the base by carcinomatous tissue.

A more extended necrosis may result in (*a*) Fig. 2—defects in which the base is free and the entire periphery is carcinomatous; (*b*) Fig. 3—defects in which part of the base and periphery only are carcinomatous; (*c*) parts of the periphery are carcinomatous, either at one point (Fig. 4) or at more than one point (Fig. 5) equally or unequally.

Fig. 6: The degree of necrosis is near the maximum and the bulk of the tumor is digested away, leaving a base which is entirely free of carcinoma and a periphery in which small fragments of definite tumor tissue appear or in which it is difficult to say whether one is dealing with hyperplasia or malignancy.

It is in just such cases as last described that the chief difficulty arises in formulating an opinion as to the primary benignity or malignancy of the given defect. For one may argue equally well that (*a*) the tumor was primary and the necrosis was extensive and secondary, or (*b*) the ulcer was primary and a malignant transformation has occurred at one point. In either case the microscopical picture is identical.

It is only with a lesion of this kind that it is ever possible to say with any degree of certainty that carcinoma has become implanted upon an ulcer. In the others,—cases of ulcerated carcinoma—the picture at the moment of examination is so overwhelmingly that of tumor that one must consider the superimplanted defect as secondary and unimportant. The actual percentage of mixed lesions in the total is very small, in our series 2 per cent.

In an argument of this nature evidence from clinical sources is unreliable and must be disregarded. For it is well known that even under the best of conditions the diagnosis of ulcer is always difficult and frequently is only decided at exploratory operation. "Ulcer" symptoms are frequently proven on operation to be of a neurogenous or functional nature or to be dependent upon lesions in foreign viscera, either near by, as in the gall-bladder, or at a distance, as in the appendix. To say then, that the previous symptoms of the patient, from whom an ulcerated carcinoma has been removed, point to the preëxistence of an ulcer, upon which the tumor has been implanted is, therefore, fallacious. The futility of this argument is further apparent when it is considered that a preëxisting ulcer might have healed entirely and that the tumor which was found was an entirely new lesion.

Much food for thought was given by the arrival in the laboratory of specimen "U," described above. (Chronic gastric ulcer with carcinomatous regional lymphnodes.)

The explanation of this anomalous condition could be made upon only one basis which our observations, previously outlined, supported, namely that a squamous cell tumor had grown in the stomach wall and had metastasized in the lymphnodes. That in the tumor itself the maximum amount of necrosis had occurred and the entire carcinoma had been digested away, leaving what was apparently a benign ulcer.

This brought up the question of the nature of those large indurated

FIG. 1.

FIG. 2.

FIG. 3.

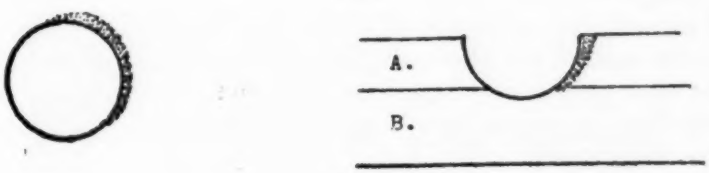

FIG. 4.

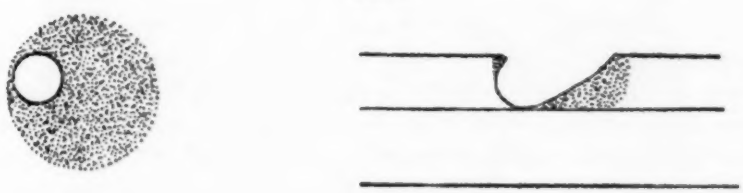

FIG. 5.

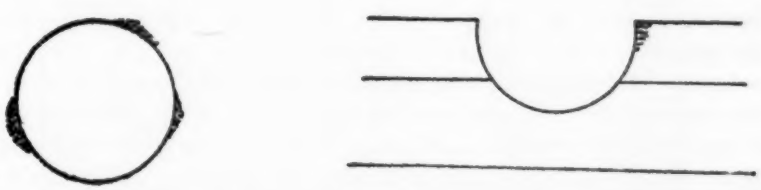

FIG. 6.

FIGS. 1 to 6.—Diagrammatic representation of the possible relationship of a defect to a carcinomatous lesion to the stomach wall. A full view and a cross-section is given in each figure. The dotted areas represent carcinoma. The segments of the circles represent the relative position of the defect. *A*, mucosa; *B*, remainder of stomach wall.

and crateriform, perforating or penetrating ulcers of the lesser curvature and posterior wall of the stomach. For many reasons these can be considered to form a class by themselves. And in the light of what our studies have shown, especially specimen "U," it is not unreasonable to question whether these were not originally carcinomatous tumors in which the amount of necrosis has been near to or at the maximum. There are several points which support this view:

1. Ulcers situated elsewhere, such as those near the pylorus or in the duodenum, are practically never known to undergo carcinomatous change.

2. Carcinomatous changes are found only in ulcers of the lesser curvature and posterior wall. The mixed lesion studied by us was an indurated defect situated on the lesser curvature.

3. The gross appearances of these lesions give no indication of the true microscopical structure.

4. Among our specimens we found examples which illustrate the progressive changes from the lesion which is truly an ulcerated carcinoma to that in which the only evidence of the carcinomatous origin is the presence of a metastatic focus in a regional lymphnode. Intervening between these, all stages can be shown which had resulted from varying amounts of necrosis.

RÉSUMÉ OF MATERIAL STUDIED

Forty-eight ulcerated lesions of the stomach comprise the material studied. This includes 39 chronic ulcers, 7 ulcer-like carcinomatous lesions, 1 ulcer with regional carcinomatous lymphnodes, and 1 mixed lesion (resembling an ulcer but with carcinoma at many places on its periphery). This summary does not include 5 gastrojejunal ulcers and 2 healed ulcers which were also investigated.

CLINICAL SIGNIFICANCE OF THE RESULTS

In going through our records one finding is significant, namely, that 14.6 per cent. of the specimens studied were ulcer-like lesions which on microscopical examination proved to be ulcerated carcinomata. If the specimen of ulcer with regional carcinomatous lymphnodes and the mixed lesions are included, then 18.7 per cent. of the ulcer-like lesions were associated with carcinoma. In all of these it was not possible to make the diagnosis of malignancy from the gross appearance of the specimens as they were observed at the operation. In view of this fact the surgeon must consider that the large indurated ulcers occurring on the posterior wall and lesser curvature of the stomach are potentially carcinomata until the microscope discloses their true nature. Any method of treatment which does not aim at a complete removal of the lesion, with the appropriate regional lymphnodes, must be considered faulty, inasmuch as the risk is always present that a carcinomatous lesion has been allowed to remain. In the same way any method of treatment, such as the *cautery method of Balfour,* which destroys

FIG. 7.—Edge and base of benign gastric ulcer (x 60).

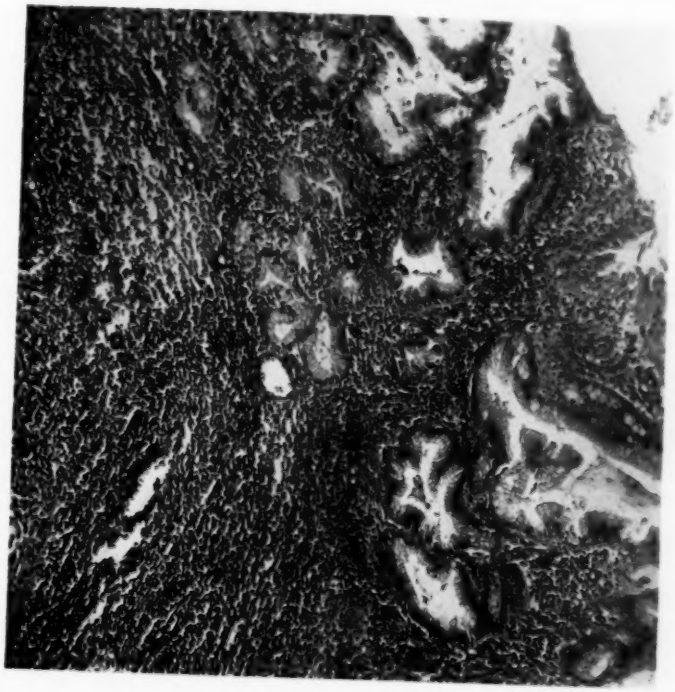

FIG. 8.—Same ulcer (x 80).

FIG. 9.—Specimen "W."

FIG. 10.—Specimen "W." Edge of lesion showing no carcinoma (x 60).

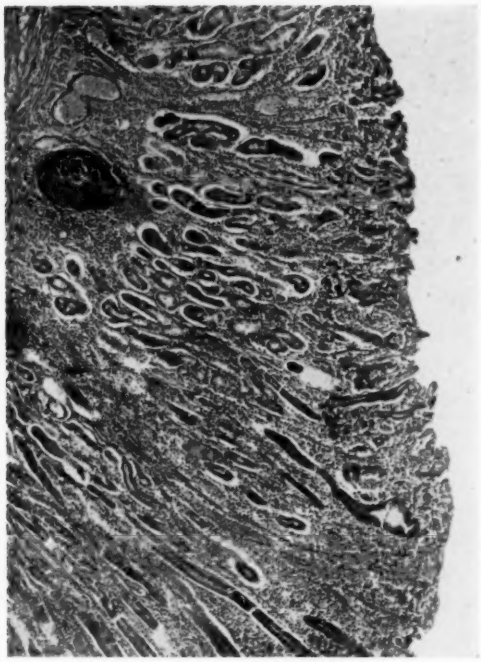

FIG. 11.—Specimen "W." Near the edge of the lesion showing superficial carcinoma (x 60).

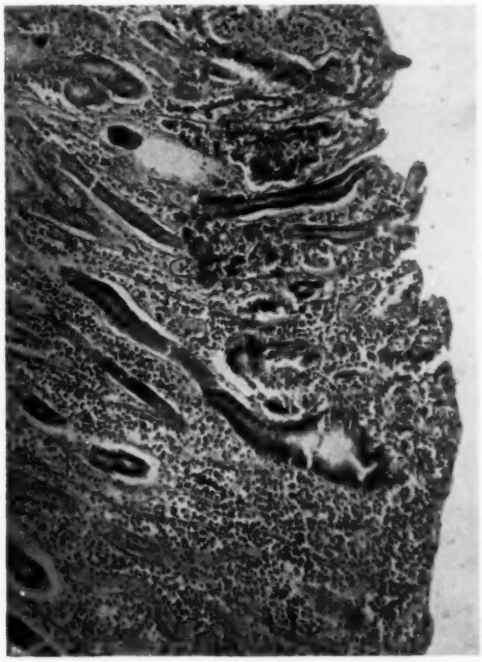

FIG. 12.—Specimen "W." Same area (x 100).

FIG. 13.—Specimen "W." Edge of lesion showing carcinoma of edge and base (x 60).

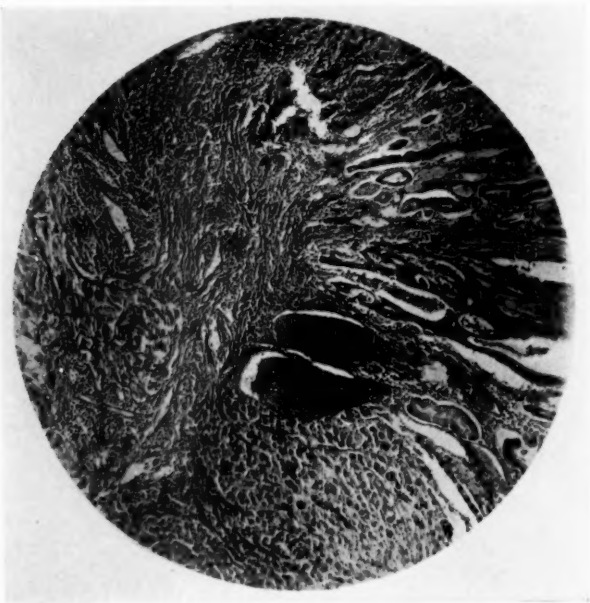

FIG. 14.—Specimen "W." Edge of lesion showing early stage of adenocarcinoma and also colloid carcinoma (x 80).

FIG. 15.—Specimen 26. Edge of ulcerated carcinoma showing carcinoma at "A" (x 80)

FIG. 16.—Specimen 26. Base of ulcerated carcinoma immediately adjacent to Fig. 15 (x 60)

FIG. 17.—Specimen "U."

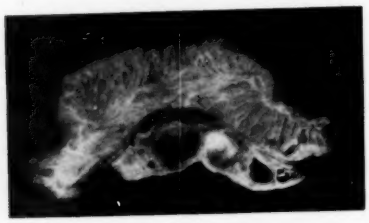

FIG. 18.—Healed ulcer showing cystic changes in mucosa.

the lesion, is open to the same objection that the nature of the lesion is not determined accurately and the treatment is of dubious value if the pathological process is of carcinomatous origin.[1]

SUMMARY

This investigation has not furnished absolute proof that carcinoma of the stomach can arise in a preëxisting ulcer, which was the problem under investigation. Evidence has been submitted which indicates in all probability that in one specimen out of the forty-eight examined there is present a carcinoma arising in an ulcer. This problem still needs further study, but from the results reported by others and from our own, it is fair to presume that in a very small percentage (1 to 2 per cent.) of ulcerated gastric lesions the morphological microscopical evidence indicates that carcinoma has arisen in an ulcer.

The majority of ulcerated gastric lesions, however, are either simple chronic ulcers or definite carcinomata. Any etiologic relationship of gastric ulcer to gastric carcinoma cannot be traced in these specimens.

Ulcerated gastric lesions which appear benign grossly were proved by the microscope to be malignant in 18.7 per cent. of the cases studied by us.

It is lesions of this sort which we believe have given rise to considerable confusion in the past. It is impossible to state whether they represent an ulcerating carcinoma or an ulcer which has undergone malignant transformation. The latter interpretation has been made by some investigators and this explains why some workers consider that a large percentage of chronic gastric ulcers show a carcinomatous change. We do not believe that this interpretation is justifiable, although these confusing lesions have a great significance so far as the surgical treatment of the ulcerated lesions of the stomach are concerned. The surgeon should therefore treat all of these lesions as though they were malignant tumors.

NOTE.—Most of the material was furnished by the Surgical Service of Dr. A. A. Berg. We are indebted to the kindness of Dr. W. Crump and Dr. J. W. Forbes, each for one specimen.

[1] A local excision of these lesions when there is no metastatic involvement of lymphnodes at a distance of two centimetres beyond the ulcerated margin has been shown by the authors, in another investigation, to remove the entire local malignant process in at least the majority of the cases.

AN IMPROVED MILITARY AMBULANCE

By George W. Hawley, M.D.
of Bridgeport, Conn.

One of the impressions one makes on coming in contact with the work of the "Service de santé" in France is the fact that no particular advance has been made in the matter of ambulance construction. As a rule, the familiar type of ambulance is used which has closed sides, supports for two tiers of stretchers, and doors opening in the rear. In addition provision is made for housing the stretchers against the roof and folding the stretcher supports out of the way, so that each ambulance may be converted into a 'bus with seats along the sides for the transfer of walking convalescent patients. In this way they are made to serve a double purpose.

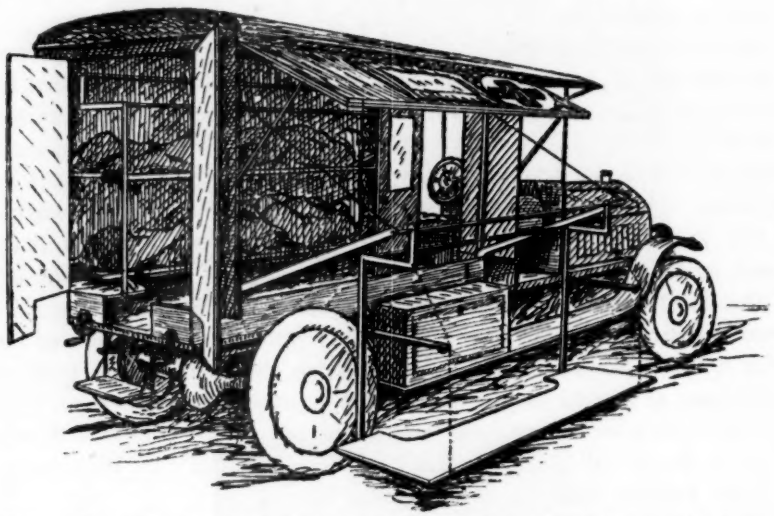

Fig. 1.—Perspective view of ambulance, showing side openings and swinging stretcher frame.

After watching the handling and transfer of large numbers of wounded men one is struck by the extraordinary amount of labor which is entailed. It requires at least three, and more often four, men to lift each stretcher high in the air as it is pushed end first into the ambulance. This is repeated four times for each ambulance.

In order to do away with the unnecessary labor and to substitute a simple for a clumsy method of loading, I have designed an ambulance body (Figs. 1 and 2) which loads from the side by means of a swinging frame. This frame is raised and lowered by a crank at the rear of the ambulance. When the frame is lowered it hangs by the side of the car and close to the ground, where two men can easily place the stretchers on the frame with-

out undue lifting. This in itself makes it possible to handle the wounded with less jarring and with more safety. With the stretchers in place the frame is raised into the ambulance and the side closed. A simple device locks the frame when housed. Provision has also been made to insure the lifting apparatus from accident.

A front door has also been supplied which makes it possible for the

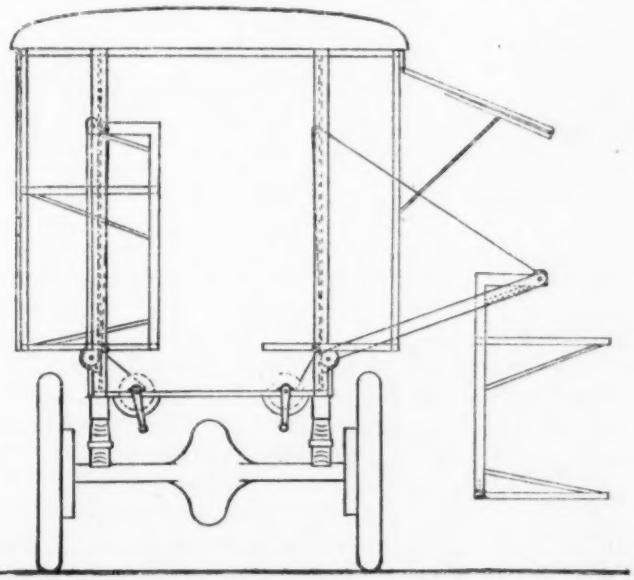

FIG. 2.—Rear elevation of ambulance (diagrammatic), illustrating swinging frame with lowering and raising mechanism operated by crank.

attendants to care for the men without getting out of the ambulance. There is sufficient passageway between the stretchers for a person to walk, and with an electric light in the roof the surgeon is able to watch his passengers from the driver's seat.

The inside construction is such that this ambulance can be used as a 'bus without changing it in any way. The bottom of the two swinging frames acts as long side seats.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting, held November 14, 1917

DR. WILLIAM A. DOWNES, Vice-President, in the Chair

WEBBED FINGERS

DR. W. S. SCHLEY presented two cases of webbed fingers, as follows:

CASE I.—Girl, age fifteen years, was admitted to hospital March 5, 1914, with congenital deformity of the left hand, all the fingers of which were fused; the nails of the index and middle fingers were fused in one large broad nail. Joints freely movable. No tenderness or pain in fingers. She complained of inability to grasp or pick up objects. Function greatly limited. X-ray showed the first metacarpal bone to be shorter than the fellow on the other side; the second one smaller but perfectly formed; the third very short and thick and imperfectly formed and the epiphysis united. The fourth is short but fairly well formed. Its epiphysis has united. The fifth is almost normal in size and shape and the epiphysis has not united. The phalanx of the thumb is almost normal in size and shape and the epiphysis for the first phalanx has not yet united. The first phalanx for the index finger is fairly well formed. The exact size and shape of the terminal phalanx is difficult to determine. The first phalanx of the middle finger is well formed and the second and third phalanges are partly formed. The first phalanx of the ring finger is well formed. The second phalanx is very short and almost rudimentary. The third phalanx is fairly well formed. In the little finger, the first phalanx is well formed and the second is very small and deformed and apparently fused with the terminal phalanx.

First Operation, March 6, 1914: Incision between thumb and index fingers. Skin edges approximated as far as possible without tension, remaining raw surfaces covered with graft (Thiersch). Grafts covered with rubber tissue and band splinted. Dressed eighth day. Complete union.

Second Operation, March 20, 1914: Incision between middle and ring fingers *carried down well in cleft* to heads of metacarpals without cutting intermetacarpal ligament. Skin edges sutured as far as they would come easily. Thiersch graft covered cleft and remaining raw area. Dressed seventh day. Complete union. Thus the hand was divided into three portions: Thumb, index and middle fingers, ring and little fingers. The result was so satisfactory to the patient that she refused further operation and was able to earn a living in a domestic capacity.

Skin grafting was done here, as the classic Didot-flap operation seemed to offer insufficient skin for complete covering and because it was thought that an incision carried unusually far down in the cleft and successfully grafted gave less tendency to later closure of the cleft and shortening of already short fingers.

CASE II.—A child, seven years of age, was admitted to hospital, August 23, 1917, with a congenital deformity of both hands. There was an almost complete web between the third and fourth fingers of the left hand. On other hand a similar condition exists, but to less extent, being only half the length of the fingers. X-ray showed no bony deformity. A similar operative procedure was done. An incision was carried well down cleft and primary graft.

These cases were shown as examples of *skin graft operation*. There seems less tendency to fuse at cleft than the Didot flap, but unless there is primary graft union there is more tendency to cicatrix.

LACERATED WOUND OF THE LEG

DR. JAMES M. HITZROT presented a boy of five years who was run over by an automobile shortly before his admission to the New York Hospital, October 23, 1917.

On admission there was an extensive laceration on the outer aspect of the left leg which extended from the upper third of the thigh to below the knee. In this region the skin had been stripped away from the underlying tissue to the inner side of the thigh. There was laceration of the biceps and vastus externus, and the outer head of the gastrocnemius muscle. Street dirt was ground into the fat, muscle, the outer portion of the capsule of the knee-joint, and throughout the outer aspect of the wound.

About four hours after admission the child was taken to the operating room. After preliminary skin sterilization with iodine (3½ per cent.), the wound was irrigated with 1 per cent. formalin solution for about ten minutes. This was neutralized by ten volume peroxide solution and the wound then washed out with normal saline solution. All street dirt was carefully cut away during the irrigation and the muscle and fascia into which the dirt was ground excised by sharp dissection. The wound was then closed by interrupted silkworm stitches, after making three drainage openings through the avulsed skin flap along the posterior surface of the thigh. These drains were removed after twenty-four hours. The child made an uninterrupted recovery and the wound healed by primary union. The only temperature reaction of any moment occurred as a result of the tetanus antitoxin given the day after the injury.

The case was shown to demonstrate the efficacy of formalin as a wound antiseptic and the neutralization of its action by peroxide as shown by Stewart of Minneapolis. Dr. Hitzrot stated that he had used this method in

five lacerated wounds and a few compound fractures with equal success. The penetrating power and antiseptic action of formalin is so far the most potent of any of the antiseptics. Its destructive action on the tissues apparently is completely neutralized by the peroxide as Stewart stated.

In wounds which are possible of immediate closure and in which antisepsis is desirable, formalin is to be carefully considered, especially if used in the above way, and in wounds in which immediate antisepsis is desirable, although not susceptible of immediate closure, formalin as an antiseptic must be given due consideration. Further than its use in the preliminary or early sterilization, it cannot be used over longer periods because of the irritating qualities and the danger of kidney irritation due to the constant absorption of small quantities of the antiseptic.

Dr. William C. Lusk said that in his hands for a number of years chinosol (oxy-quinoline-sulphate), used in the first-aid treatment of fresh traumatic wounds, had quite evidently a disinfectant action. When there was no tissue deprived of its vitality in these wounds, he expected primary union to quite generally take place following suture of the severed structures, if the latter had been repeatedly soused with the chinosol solution. At the present time, for the primary disinfection of wounds, he used an aqueous solution of chinosol of a strength of grs. iv to ℥i. He mentioned a single instance of its use in the case of the repair of an anal canal which had been torn completely through by impalement on a spike, the tear reaching to a height of about two inches, and extending backward into the sacral region. The patient had had a large movement of the bowels just before the operation. The last record of the condition of the wound, which was made by himself nine days after the operation, stated that on this day, after the bowels had been moved, the suture line of the anal canal appeared intact without fistula formation. The portion of the wound behind the suture line of the sphincters had been left open for drainage.

The Council on Pharmacy of the American Medical Association, while they accredited to chinosol powerful antiseptic properties, had condemned it as a disinfectant. Their tests of the germicidal efficiency of this drug, however, had been made in the bacteriological laboratory and not in wounds. Chinosol, in the strength used, was non-irritating to wounds and did not coagulate albumin.

RETROSTERNAL GOITRE

Dr. Nathan W. Green presented a woman, aged thirty-seven years, who was admitted to hospital September 23, 1917, complaining of hoarseness and a sense of pressure in the throat. No swelling of the thyroid was apparent.

Bronchoscopic examination showed the trachea flattened anterior-posteriorly about three inches from the rima glottidis. There was an apparent bulging in the posterior wall of the trachea which at first was thought to be a tumor, but later was found to be due to outside pressure. In the left main

bronchus was evidence of some inflammation. It was evident that there was pressure on the trachea from some outside growth (goitre small and retrosternal). Further than this, as the patient's head lay over the table in the Rose position, a small swelling was seen to appear from behind the sternal notch.

October 10, 1917, Doctor Green removed a small, round, symmetrical tumor, about the size of a small hen's egg, under local anæsthesia by a curved incision which was made low down over the thyroid. The patient was able to talk all through the operation, and upon pressure being relieved by the enucleation of the colloid cyst, which was posteriorly located in the isthmus, she expressed an immediate feeling of relief which persists to the present time. She was discharged on the eighth day after operation with a temperature of 98.4° and a pulse of 64.

Dr. Howard Lilienthal called attention to a method of reaching retrosternal goitre when it is so large that it cannot be drawn up, by splitting the sternum from above down and then retracting the two halves laterally. This makes room enough for the introduction of one finger, which can then lift the goitre out. He cited a case in which he followed this procedure with remarkable success; he split the sternum (Milton's method) and then, according to the Sauerbruch method, cut it through horizontally on one side and got two fingers in easily; in this particular case there was a thyroidea ima artery which was seen, caught, and tied in the mediastinum.

Dr. Robert T. Morris cited an instance of difficulty in ligating the thyroidea ima artery in a case of retrosternal goitre where there was difficulty in ligating that artery because of its position behind the sternum. The resource consisted in slipping on a pair of forceps which were left in place on the artery for twenty-four hours, thus avoiding the complicated work of controlling hemorrhage in that situation by ligature.

CICATRICIAL STRICTURE OF ŒSOPHAGUS

Dr. Nathan W. Green presented a woman, forty-six years old, who, when eight years old, drank some fluid lye by mistake.

She was treated by an outside physician for a year, and then came to St. Luke's Hospital, where an Abbe string-cutting operating was performed by Dr. B. Farquhar Curtis. This relieved her for eight years. Then she again began to have difficulty in swallowing, and for the past four years, from 1912 to 1916, she had been back, having bougies passed by Doctor Virgin.

She was irregular in her visits, contrary to advice, and on April 24, 1916, the stricture had so closed that she could not swallow solid food; on April 27, 1916, she was unable to swallow fluids. She had lost weight and become anæmic and weakened. When finally admitted to the hospital, on April 29, 1916, the stricture was found to admit only a small filiform bougie. This was passed with the aid of the œsophagoscope. The stricture was then dilated to twenty-four French with bougies by Doctor Green. It appar-

ently was three or four inches in length and just above the cardia. On the ninth day of May she ran a temperature and had increase in fremitus, and the breath sounds were bronchovesicular from the angle of the scapula to the base of the left lung. On the thirteenth day of May, 1916, she ate solid food without discomfort, and her general condition was noted to be good. She was discharged from the hospital on that day, and returned occasionally for the passage of the bougie. She was readmitted on February 26, 1917, with again the complaint of difficulty in swallowing.

On February 28, under gas and ether anæsthesia, a gastrostomy was performed, excising the scar of the former wound and doing a Senn operation. On opening the abdomen, a few adhesions were found about the former gastrostomy opening. On March 14, under gas and ether anæsthesia, an attempt was made to pass the œsophagoscope from below to the stricture, and the cardiac end of the stomach was found, but the stricture could not be sufficiently dilated. On March 20 the patient had swallowed a string two days previously, and this string was brought out from the gastrostomy wound. The stricture had narrowed about the string, and a small bougie passed with difficulty. The string which had passed through the gastrostomy wound, the upper end being attached to the left ear, was tied to two strong, heavy cords, and these were pulled through the œsophagus, leaving both ends of each cord extending from the mouth and the stomach; to one of these cords was attached a small Billroth bougie which was pulled inside the stomach through the gastrostomy wound and into the stricture of the œsophagus; the other cord was then pulled back and forth with a sawing motion, and the Billroth bougie gradually advanced upward through the stricture; this bougie was withdrawn, and in turn larger bougies were similarly introduced and the sawing repeated until the maximum sized bougie (No. 41) was introduced; after the stricture was sawn with the cord, the bougie was left in place for several minutes; it was then withdrawn and a single cord left attached to the patient's left ear down through the œsophagus and out through the gastrostomy wound, to be used in further dilatation, if necessary; a large rubber tube was put in the gastrostomy wound.

After operation the patient ran a slight temperature for three days, which gradually subsided to normal.

The subsequent history is that the patient returned to the hospital for the passage of a No. 40 French bougie, at first once a week, then every two weeks, and latterly once a month. She has gained eighteen pounds since April 1, 1917.

Although she returns quite regularly, still the necessity of passing the bougie is demonstrated by the resistance to it by the stricture at each sitting. It shows the necessity of keeping up this dilatation for a long time, probably for years, at increasing intervals.

SPLENECTOMY FOR PERNICIOUS ANÆMIA

Dr. William A. Downes presented a man, aged thirty-two years, who was admitted to St. Luke's Hospital, December 30, 1914, complaining of weakness, dizziness and roaring in head—five months' duration. Fainted one week ago. No previous illness. Examination showed a fairly well-developed and nourished man; with liver slightly enlarged; spleen not felt.

Blood.—White blood cells, 7500; polymorphonuclears, 70; lymphocytes, 30; red blood cells, 1,500,000; hæmoglobin, 30 per cent.; 1 megaloblast, 2 normoblasts, 1 myelocyte, polychromatophilia and stippling. Blood culture negative. Wassermann negative. Stool negative for parasites. Stool negative for blood.

January 11, 1915: Blood transfusion was done. Blood examination after transfusion showed 4,000,000 reds and 70 per cent. hæmoglobin. January 18, 1915, splenectomy was done. February 3, 1915, red blood cells, 4,000,000; hæmoglobin, 55 per cent.; white blood cells, 9500; polymorphonuclears, 74; lymphocytes, 26.

Blood Examination, February 18, 1915.—Red blood cells, 4,200,000; hæmoglobin, 75 per cent.

Pathological Report.—Spleen measures 12 × 8 × 3 cm.

Microscopic Examination.—Fibrosis and lymphoid hyperplasia.

Blood Examination, November 14, 1917.—Red blood cells, 4,500,000; white blood cells, 18,000; hæmoglobin, 100 per cent.; polymorphonuclears, 65; lymphocytes, 35; no abnormal cells.

He has followed his vocation as an embalmer for the past two and one-half years without interruption. He feels as well as ever in his life, and has had no treatment since discharge from the hospital February 20, 1915.

EFFECT OF SPLENECTOMY

Dr. James M. Hitzrot read a paper entitled "The Effect of Splenectomy on the Normal Individual and in Certain Pathological Conditions, with Illustrative Cases."

Dr. Hitzrot also showed a case of traumatic rupture of the spleen in a boy aged fourteen, who was admitted to the New York Hospital on September 11, 1913, with a history of having been thrown from a truck about four hours before admission. The operation was done a little over four years ago and the patient has grown and developed normally.

Doctor Hitzrot showed a second case of splenectomy. The operation was done for acholuric jaundice in a woman of twenty-seven years, three and one-half years ago. She is now entirely well and free from the symptoms which existed before the operation. Her blood count on November 12, 1917, was: red blood cells, 3,250,000; hæmoglobin, 87 per cent.; leucocytes, 18,600; polymorphonuclears, 86 per cent.

Doctor Hitzrot showed a third case of splenectomy, which was done for pernicious anæmia in a man of thirty-seven years, six months ago.

The man is now entirely well and free from the weakness, etc., which

existed before the operation. He has gained seventy-eight pounds in weight and his blood count on October 5, 1917, was: red blood cells, 5,200,000; hæmoglobin, 80 per cent.; leucocytes, 11,200; polymorphonuclears, 52 per cent. The case was one in which the anæmia was due to some sort of hæmolysis or an hæmatogenous crisis, and like the case presented by Doctor Downes, has shown a marked improvement since the removal of the spleen. It is yet too early to predict the outcome of the case, but Doctor Hitzrot believes that it was in this type of pernicious anæmia in which splenectomy was indicated and in which the removal of the spleen seemingly improved and sometimes cured the patient.

Dr. Howard Lilienthal cited fourteen cases of splenectomy, of which three were for Banti's disease, and one was combined with rather an unusual extent of traumatic rupture of the spleen. In this case the spleen weighed four pounds, was degenerated and was pronounced by the laboratory of Mt. Sinai Hospital to be a case of Banti's disease. The patient, a girl of fourteen, fell, striking her abdomen against the curbstone, soon after going into profound shock. The following day at the time of operation the abdomen was found filled with blood and serum, and when the operator (Doctor Lilienthal), not knowing that it was a ruptured spleen with which he was dealing, tried to peel away what he thought was an adhesion, he found this was the omentum which had glued down the rent in the spleen; there followed a terrific hemorrhage and the spleen was immediately removed. The patient is now in perfect health with a normal blood picture. Another splenectomy, for Gaucher's disease, was in a woman of forty-five, in whose case the spleen weighed about 13½ pounds. The patient was a very small woman, and only complained of pains in her legs. Her liver was ptosed into the pelvis. Operation in this case has been followed by a perfect recovery.

Doctor Lilienthal then referred to another case the diagnosis of which had always been doubtful in his mind. A man came to him with a history of having been jaundiced for some years. He had had repeated attacks of biliary colic; Doctor Einhorn said he had gall-stones. Doctor Lilienthal, in his otherwise careful examination failed to have a blood examination made, as he did not consider it anything other than a case of gall-stones. On operation no gall-stones were found; a cholecystotomy was done in the hope of relieving the jaundice, then a search was made in the direction of the common duct where something was felt that was believed to be a chain of stones in the common duct. When a needle was inserted pure blood oozed out and it was found that the supposed stones were calcified plates in the portal vein. The case was doubtless one of blood jaundice or perhaps of Banti's disease. The patient died soon after of recurrent hemorrhages. No autopsy.

Doctor Lilienthal then discussed the technic of splenectomy, calling attention to the difficult cases in which the spleen is adherent to the diaphragm,

and in which its removal is impossible. In order to be sure and save the hundredth patient every precaution should be taken in every case in which the spleen is to be removed where there is any question as to the mobility of the organ. First of all the question of blood transfusion before operation: this is not to be done unless the patient is decidedly anæmic; if the hæmoglobin is in the 20's a blood transfusion is indicated before operation. If the spleen is large and the patient not very anæmic the tendency should be rather to have the donor ready and the transfusion done following operation if necessary. Doctor Lilienthal, in preparing a patient for splenectomy, always makes use of tourniquets around the thighs. The blood-pressure should be carefully taken before the tourniquets are applied and again just before the operation; there will be found a very great diminution in the blood-pressure by this method. In a normal person it has been possible to reduce the blood-pressure 60 mm. Hg. If shock or hemorrhage accompany the operation, the tourniquet should be removed from one leg and this will save the necessity for transfusion, and it will also prevent a large amount of hemorrhage. The question of the incision is of secondary importance. It is all right to begin with the sagittal; if formidable adhesions in the upper abdomen make it impossible to work through this opening it is suggested that another incision connected with the tip of the sagittal incision and running down along the border of the ribs be made. This has been criticised as dividing the nerves, but although this criticism is true the speaker has never seen an atrophy resulting, and the wounds have healed beautifully, and one can get as near as possible to the place of greatest danger, the region of the diaphragm. Evidently the intercostal nerves reunite. If the adhesions are to a movable organ, the case is comparatively simple, but if they are attached to the diaphragm it is necessary to have an opening big enough to get two hands in and work under the eye, thus restricting hemorrhage. Doctor Lilienthal stated that he had made the foregoing incision in seven cases and wished to recommend it highly.

Dr. Nathan W. Green stated that he had been asked to see a case in consultation of a man who had been going through an attack of paratyphoid fever; the temperature had dropped, then started to climb again and he had an enlarged spleen with great tenderness over it. He was asked to see this case in the hope that he would do a splenectomy and was told by the house physician that abscess of the spleen was found in 40 per cent. of all paratyphoid cases coming to autopsy. In this case no operation was performed and two weeks later the spleen was steadily diminishing in size, tenderness was disappearing, and temperature was coming down.

Dr. William A. Downes, in replying to a query, stated that from his experience, which was based on eight cases, he believed that some cases of pernicious anæmia were benefited by splenectomy, others not at all. He considered that he had made a mistake in two or three of his cases, operating where the disease had progressed so far that it proved of no real advantage.

DUODENAL LEAKAGE THROUGH THE COMMON DUCT

Dr. James M. Hitzrot showed a specimen removed at autopsy of duodenal leakage through the common duct. The patient, a woman of fifty-four, was admitted to the New York Hospital, First Surgical Division, September 5, 1917, complaining of pain in the right hypochondrium which began as sharp severe colic in the upper abdomen, especially on the right side, and which radiated into the back. She vomited. She has had five similar attacks since an operation done in November, 1916, at which time a drainage operation, with the removal of a number of stones from the gall-bladder, was done by another surgeon. These latter attacks have all been similar in character to those which preceded the first operation. Patient has not been jaundiced except on one occasion before the first operation. On admission, patient was slightly jaundiced. The abdomen was distended and there was tenderness with rigidity over the whole upper right half of the abdomen, most marked in the region of the previous operation. Her temperature was 97.4°, leucocytes, 17,500; the urine contained a few white blood cells, no casts, and epithelial cells.

On September 7, 1917, under gas and ether, a cholecystectomy, choledochotomy and transduodenal choledochotomy was done through a six-inch hockey-stick incision. On opening the abdomen the omentum, stomach, and liver were all plastered together against the parietal peritoneal wall in a dense mass of adhesions which were freed with considerable difficulty. The gall-bladder was exposed, and found to be markedly thickened and to contain a few stones. The common duct was enormously dilated and stones could be felt in the hepatic duct from the liver down through the common duct clear to the ampulla, where there was a mass of very hard stones which were distinguished with difficulty from the nodular enlargement of the head of the pancreas. The gall-bladder was excised. The common duct was opened and perhaps a dozen or more stones with a lot of biliary sand removed; part of the stones being brought down from the hepatic duct and part from the duct in the wall of the duodenum. After these stones were removed one stone was found high up in the hepatic duct, and was dislodged from the liver with considerable difficulty. One stone was likewise lodged in the ampulla and after considerable manipulation was squeezed out through the opening in the duct. After this was done, a hard mass was felt slightly to the left of the probe in the common duct, which could not be dislodged. A bent probe was then passed into this region, and there was a distinct click as if striking a stone. A transverse duodenal choledochotomy was then done and the duct opened through the posterior wall of the duodenum at the ampulla and a dilated portion of the duct, almost a diverticulum, opened and from this three stones were removed. The opening was partially closed with chromic catgut and the opening in the duodenum closed with three rows of chromic stitches, the last stitch fastening a piece of the omentum to cover the outer row of stitches. A rubber tube was then passed into the dilated common duct and fastened

into position with one suture and the duct closed about it. Three cigarette drains and one rubber-dam drain were placed about the stump of the gall-bladder, in the gall-bladder fossa and in Morrison's pouch and behind the duodenum. The wound was then closed in layers, using double-loop silk-worm tension stitches.

The patient made a satisfactory convalescence. The drains from about the tube in the duct were removed on the sixth day. On the seventh day there was a profuse watery drainage from the wound. Methylene blue given by mouth appeared in the wound secretion between forty-five minutes and one hour. This discharge increased on the next two days and food and fluid by mouth was stopped and rectal fluid given. The patient, however, never improved sufficiently to permit of an operative investigation and died eleven days after the operation. The natural supposition was that the duodenal wound had leaked.

A partial autopsy by Doctor Spencer showed that the leakage had occurred through the opening in the common duct, and that the anterior duodenal suture line was intact. The specimen exhibited showed that the mucosa about the opening in the ampulla had ulcerated where it had been closed by suture, leaving an opening about 0.75 cm. in diameter in the wall of the duodenum communicating with the dilated common duct. Leakage had occurred through this opening into the duct and out through the drainage opening in the common duct. In retrospect, Doctor Hitzrot felt that it would have been difficult to have met this condition by a second operation, and showed the specimen to demonstrate a serious complication of transduodenal choledochotomy when dealing with a large dilated common duct.

Stated Meeting, Held December 12, 1917

Dr. William A. Downes, Vice-President, in the Chair

LONG FREEDOM FROM RECURRENCE AFTER REMOVAL OF CANCER OF STOMACH

Dr. John Douglas presented a man, thirty-five years old, upon whom he had performed a resection of the pylorus together with a resection of a portion of the liver to which the carcinomatous ulcer was adherent, five years ago. The operation was performed on November 28, 1912. Symptoms of ulcer were present for twenty months previous to operation. The lesion found was a large callous ulcer of the lesser curvature which had perforated and become adherent to the liver. Radiographic examination demonstrated a typical hour-glass stomach. Pathological examination of the specimen showed carcinoma developing in an old ulcer.

The particular points of interest in this case were the age of the patient in whom carcinoma had developed (thirty years), the technical difficulty of the resection, necessitating the removal of a wedge-shaped portion of the liver, and the evidence of old perforation closed by adhesions to the liver, and the fact that he was alive and well five years after operation.

Doctor Douglas also presented a woman, aged fifty-eight, upon whom he had performed a pylorectomy by the Bilroth No. 2 method, for carcinoma on April 19, 1912, five years and eight months ago. Her gastric symptoms had been present for two years, and a movable tumor eight to nine centimetres in diameter could be felt in the epigastric region. The pathological report was scirrhous carcinoma of the stomach.

The particular interest in this case lay in the fact that although the patient states that her tumor had been present for eighteen months previous to the operation, there was no glandular metastasis, and the operation was not technically difficult.

Doctor Douglas had done eleven resections of the stomach for carcinoma, nine being pylorectomies. Of the nine pylorectomies four are still alive, the two cases shown (one five years and eight months, and the other five years ago) and two others, one five years and two months (an old lady who is now seventy-five years old), and one sixteen months. Two died as an immediate result of operation, one from gangrene of the leg, and one from what Doctor Douglas believed was heat stroke; the others lived from six to seventeen months after operation.

Friedenwald stated that out of two hundred and sixty-six of his own cases of carcinoma of the stomach not a single one was alive, and Peck in his analysis of five hundred and twenty-seven cases admitted to the surgical services of several large New York hospitals in the last five or six years, could find records of but thirty-three in which radical operation had been performed, of whom only twenty-three recovered, of which small number but eight were known to be alive and well. Three of the cases were at four years, one at two years and six months, and the others at shorter periods. Therefore these cases are presented, which with the other two cases he reported makes a somewhat less gloomy prognosis for a limited number of cases.

Dr. George Woolsey called attention to the long period of time which had elapsed in both these patients and considered these very encouraging cases. He referred to two of his own cases, well four years or over, out of eighteen cases resected, of which the mortality was one. He considered that the variety of the tumor and the presence or absence of glandular metastasis had much to do with the prognosis. Glandular metastasis occurs late, and in many cases some or all enlarged glands are not carcinomatous.

Dr. Willy Meyer considered it important to differentiate between cases of carcinoma of the stomach of primary origin and carcinomatous degeneration of an ulcer. He stated that it was his belief that a carcinoma occurring on the borders of an ulcer was often less virulent than one occurring in the base of an ulcer. He recalled only one case of primary carcinoma of the stomach well more than ten years and referred to two occurring in the borders of old ulcers well for more than three years. He described one case of carcinoma developing in the base of an old ulcer in which operation prolonged life but a short time, due to the inability to perform a sufficiently

radical removal. The transverse mesocolon had been invaded and the patient appeared too weak to stand the operation. Clearly indicated: Simultaneous resection of stomach and transverse colon.

Dr. Parker Syms asked if there was anything in the pathological findings of these cases which would indicate the existence of a previous ulcer. There seemed to be a history of gastric symptoms extending over periods of two years or more.

Dr. John Douglas, in closing, answered Doctor Syms' query by stating that in the second case reported the patient unquestionably had an ulcer of the lesser curvature existing for at least two years and which had perforated, causing adhesions to the liver which were so extensive that it was necessary to remove a portion of the liver with the pylorus and a portion of the stomach. He referred to a patient whose case was reported before the Society a year ago who is still alive seventeen months after operation; in this case the tumor mass was also adherent to the liver, making it necessary to remove a considerable piece of the liver; microscopical examination showed the liver cells involved with the carcinoma. He considered in this case that it was a difficult matter to state whether or not the original condition was that of ulcer. He considered this case particularly interesting from this viewpoint, as there was a history going back only three months previous to operation, no vomiting, no pain, and only symptoms of indigestion before the tumor could be easily felt in the epigastric region. In the case of the woman presented at the present meeting there was a history of a tumor of which she had herself been conscious for eighteen months with no glandular involvement; there were enlarged glands but these were not carcinomatous.

In consideration of Doctor Meyer's point as to the difference of malignancy in tumors originating in gastric ulcers and those primarily carcinomatous, Doctor Douglas felt that this differentiation was extremely difficult. He recalled a case of a woman who had a large tumor at the pylorus diagnosed as carcinoma, and which was resected for this reason, in which the microscopical examination proved the condition to be one of indurated ulcer, not carcinomatous.

STONE IN SOLITARY KIDNEY: ANURIA

Dr. John Douglas showed a woman, thirty-two years old, admitted to St. Luke's Hospital, August 21, 1917. She states that she had a sister born with only one arm. The patient had an operation on her left appendages in another hospital nine years ago. She had an attack of renal colic on the right side seven years ago, and passed a stone from the bladder. Three years ago she had another attack of renal colic on the right side and had a radiograph taken which was negative. The following day she passed the stone.

Ten days before admission she had hæmaturia. Three days before admission she had right renal colic. Had passed no urine since day before admission. Examination showed tenderness in right costovertebral angle. No urine in bladder. X-ray catheter passed by Doctor DuBois 25 cm. No

flow of urine. No ureteral orifice found on left side. Anuria continued and uremic symptoms appeared and operation was done, with a diagnosis of stone in a solitary kidney. The kidney was exposed by a posterior incision. It was found to be almost twice the normal size and a small, conical-shaped stone was found tightly plugging the junction of the pelvis and the ureter. Convalescence uneventful. Subsequent cystoscopy with a Garceau catheter by Doctor DuBois at the hospital confirms the absence of a left ureteral orifice.

Dr. Willy Meyer referred to a patient, a young woman in whom he had done a nephrectomy for a large suppurating kidney, operated in 1892. A week subsequent to the operation the patient suddenly had total anuria. Forty-eight hours after onset of the symptoms a lumbar incision was made, the pelvis of the remaining kidney found very much enlarged and the ureter totally blocked, not by a stone but by a peculiar soft gelatinous material similar to that which had been found in the opposite kidney. Masses of this material were removed with a spoon from the pelvis, and then a catheter was passed into the ureter, washing the obstructing material out with a syringe in a retrograde way. The patient recovered from the condition and is alive to-day.

Dr. William A. Downes called attention to the inability to diagnose a condition of solitary kidney exclusively upon failure to find the ureteral opening and referred to a case of tuberculous kidney where no opening could be found on the right side, but where, after making a median, anterior incision, a well developed right kidney, probably the original focus of the tuberculosis, was found. This kidney was perhaps half the normal size, and at the juncture of the ureter with the bladder there was a mass the size of an olive, completely blocking the ureter. Eight or ten attempts had been unsuccessful in locating the opening.

BRANCHIOGENETIC CYST WITH SINUS LEADING INTO PHARYNX

Dr. John Douglas showed a girl who at birth had a small tumor about the size of an almond on the right side of the neck just above the clavicle at the inner margin of the sternomastoid. This had been operated on when she was ten months old, but had after two years returned. Since then it had opened at frequent intervals and discharged. At the time of operation the sinus was closed and the cyst was about 2 x 3 cm. in diameter. When the cyst was dissected out it was found that it was pyriform in shape, its apex being connected with a prolongation formed by a sinus running upward. This was traced upward and dissected out, a second incision being made beneath the lower jaw. It was found that the sinus connected with the pharynx just beneath the tonsil. The sinus was cut about 4 cm. from the pharynx and a probe inserted to facilitate dissection, and, when freed to its upper level, the lower end was tied to the probe which was pushed through the pharyngeal mucous membrane, and the remainder of the sinus pulled into the pharynx. It pulled off at the level of the mucous

membrane, the opening in which was then closed by a couple of chromic catgut sutures.

Dr. Dowd presented a similar case before the Society about a year ago, when he stated that it was the first case of this kind reported before the Society. In his case, however, while it was due to a failure of closure of the second branchial cleft, there was complete fistula. In this case both ends of the tract were closed, although there was a completely patent sinus between them.

Dr. Douglas added that within the past three days he had seen a man about forty-five years old, who, by holding the mouth and nostrils shut, and blowing hard, could distend the right side of his neck with air, which, when pressed on afterwards, could be emptied into the pharynx with a gurgling sound. Evidently this was due to an opening of the inner end of a branchiogenetic sinus into the pharynx.

ACQUIRED DEFECT OF THE URETHRA

Dr. John Douglas presented a patient with an *acquired defect of the urethra,* for which he had been rejected for enlistment in the U. S. Navy. The patient stated that this lesion had been present as long as he could remember, and as his parents had been dead for several years no history as to how it had been caused could be ascertained.

There was present a defect in the floor of the urethra about .7 cm. long, located about 3 cm. behind the meatus. There was present the scar of a circumcision and also evidence that sloughing had occurred, probably caused by a paraphimosis. This had caused a loss of tissue in the anterior portion of the left corpus cavernosum, a lesser defect in the right corpus cavernosum, with a destruction of most of the urethra at this level, except on its roof, as evidenced by a small strip of mucous membrane about .2 cm. wide and .7 cm. long when separated.

Under anæsthesia, a posterior urethrotomy was done. Then after a meatotomy it was found that graduated sounds up to a 30 French could be passed from the meatus to the bladder. A transverse incision through the old scar was made, and the ends of the damaged urethra were dissected out and sutured end-to-end, with fine chromic catgut. This line of suture was reinforced by a second layer formed by the sheath of the corpus spongeosum, and the skin incision closed. The catheter inserted into the external urethrotomy opening was removed on the seventh day, and on the following day the urine passed by the meatus. There was slight leakage through one of the stitch holes for a few days, but this soon ceased.

FASCIAL TRANSPLANT IN HERNIOTOMY

Dr. Irving S. Haynes presented a man, aged forty-seven years, who came under his care at the Park Hospital in October, 1917, for an inguinal protrusion on the left side. This region had been operated upon four times

during the previous ten years, as follows: The hernia first appeared about ten years ago and it was operated then and remained cured until twenty months ago, when, after lifting a heavy weight, it returned. A second operation was performed eighteen months ago. At this time the right side was also repaired. Spontaneous recurrence took place in the left side in about a week. A third operation was performed about a year ago. A hæmatoma formed, was infected, and recovery was slow, by the usual process of granulation. A cure was apparently secured. In about three weeks the hernia returned in the old scar, on the left side. A fourth operation was done about eight months ago. Healing was uneventful. There was a cure for about five months, when again a hernial protrusion was noticed.

Examination showed scars in both inguinal regions. The right side was sound. On the left side, at the lower end of the incisions and at the site of the external inguinal ring was a small protrusion about the size of half a hen's egg, that gave an impulse on coughing and disappeared when he lay down. A finger could be passed into the external ring and there seemed to be no posterior wall to the inguinal canal.

With this region the seat of four preceding operations, it was certainly a problem as to what to do that would give the best chance for a cure. He determined to apply the fascial transplant to the inside of the inguinal region so as to completely cover this area, especially the weak spot. At operation he made a transverse incision about 6 inches long above the symphysis by which the region of the external inguinal ring was bared. A vertical incision was then made in the mid-line to the properitoneal fat. This was thoroughly stripped off from the inside of the inguinal region, so that the deep epigastric vessels and the spermatic cord were thoroughly exposed. The weak region at the site of the external ring was apparent. From the right thigh a strip of fascia, 3 x 6 inches, was taken. With the patient in a high Trendelenberg position, and with strong retraction of the wound, the flap of fascia was sutured over the inguinal region. The cord and vessels were overlapped at the outside and the flap was fastened by sutures, tied after the wound was allowed to close, so that the graft extended across the mid-line to the opposite inner surface of the abdominal wall. Under the guidance of eye and fingers three mattress sutures of kangaroo tendon were placed to approximate the margins of the weak area, which was about an inch in diameter. The recti muscles were sutured together with plain gut, the fascia with interrupted chromic, reinforced by silkworm retention sutures and the skin closed with silkworm. A small drain of rubber tissue was brought out of the right angle of the skin incision. There was considerable drainage of liquid fat and serum for a week, but the abdominal and thigh wounds united by primary union. The patient was kept in bed for three weeks and then was permitted to sit up for short periods and not allowed to get out of bed until the fourth week.

At this date the abdominal wall seems perfectly solid. Œdema of the testicle and scrotum was expected but none followed.

Dr. John F. Erdman stated that he had done the fourth operation on this man, the three previous ones having been done by Doctor Moorehead. He stated that he had made a very wide resection from behind the internal ring and inverted the fascia after the method of Doctor Haynes. He had been unable at first to recognize the cord. He finally found the vas, etc., and after the method of Bassini closed the wound. He suggested that a later presentation of this patient, say in three to six months, would be of interest to all.

Dr. Alexis V. Moschcowitz stated that he believed he held the record for multiple recurrences, having operated one patient who had been operated eight times at other institutions. He suggested the possibility of curing such a tendency to recurrence as in the case of Doctor Haynes by castration of the individual, which would permit of complete closure of the opening on the affected side, and would not be quite as complicated a procedure as the one adopted by Doctor Haynes.

SPLENECTOMY FOR SPLENOMEGALY

Dr. Irving S. Haynes presented a man, aged forty-eight years, who was under his care at the Park Hospital in October, 1917. As a boy, the man had suffered a prolonged attack of dysentery. At the age of twelve he had an attack of yellow fever in the West Indies. For the past thirty years has lived in the North, during which time he had had several attacks of malarial fever, the last one twenty-two years ago. Had an attack of pleurisy two years ago. Eight weeks ago began to suffer from pain in the small of his back and in the right hip. Following the first attack of this pain, he began to suffer from pain in the left hypochondrium, which has increased. Upon examination, there is a mass to be felt in the left hypochondrium. Wassermann examination negative. On October 9, 1917, the abdomen was opened by a transverse incision six inches long above the level of the umbilicus, dividing the rectus and the abdominal wall. Nothing abnormal was found excepting the spleen three times the normal size studded with multiple cysts. Everywhere these cysts were present, the spleen was firmly adherent to the adjacent surface. Owing to these adhesions the removal of the spleen was made difficult, but it was, nevertheless, speedily accomplished. Free oozing followed the separation of the adhesions, for the arrest of which a large hot pack was placed in the splenic bed and the wound closed. The pathological examination showed the cystic nodules to have been degenerated infarcts of the anæmic type. Throughout the spleen there are disseminated other typical old and recent infarcts. The rest of the spleen pulp shows deeply pigmented cells here and there with increased thickness of trabeculæ and hyperplastic malpighian corpuscles. The patient made an uninterrupted operative recovery and left the hospital at the end of the third week after operation. Blood examination made six weeks after operation showed red cells, 4,800,000; white cells, 14,000; polymorphonuclears, 60 per cent.; smoll lymphocytes, 32 per cent.; large lymphocytes, 8 per cent.

HERNIA FOLLOWING TRANSVERSE ABDOMINAL INCISION

Dr. Irving S. Haynes presented a man, aged forty-three years, who was under his care in the Harlem Hospital from October 22 to December 10, 1917. He had been operated by one of his colleagues in the preceding April for gastric ulcer, to expose which a transverse incision had been made across the right side of the abdomen about two inches above the umbilicus, extending outward six inches from the mid-line. The patient had been a sufferer from asthma due to chronic pulmonary emphysema for many years. After the operation he suffered very severely from aggravation of his asthmatic condition, coughing continually. After this pulmonary condition had been controlled, the wound healed and he remained in perfect health until September, when he noticed a bulging in the inner end of the scar, which rapidly enlarged until it had attained the size of an orange, when he entered the Harlem Hospital again on October 22. The hernial weakness included the entire scar from the previous operation, margins of the hernia forming an ellipse six by three inches in diameter. On November 1 he was subjected, by Doctor Haynes, to operation, in which his inversion technic was carried out. The skin over the hernia in a mass 8 x 4 inches was removed by an elliptical incision. The surface of the fascia from 2½ to 3 inches beyond the margins of the hernial opening was denuded; also the surface of the hernial sac. The margins of the hernial orifice were approximated by mattress sutures of medium sized kangaroo tendon inserted through the muscle edges. When these were tied, the hernial sac was inverted and the margins of the opening closely approximated and inverted into the abdomen. A second row of mattress sutures of the same material were then placed about one inch outside of the first row. As these were tied, the preceding suture line was inverted with the margins of muscle adjacent to the hernial opening. The musculocutaneous opening was then closed by three figure-of-eight wire sutures inserted deeply into the muscles about an inch outside of the second row of kangaroo tendon sutures. When these wire sutures were twisted over separate rolls of gauze, the previous lines of sutures were still further inverted. A subcuticular drain of rubber tissue was then placed *in situ* and the skin margins sutured with black silk.

Post-operative course: During the first week the patient was troubled with asthmatic attacks. On the eleventh day the rubber tissue drain was removed. On the thirteenth day the skin sutures were removed. On the seventeenth day two of the wire sutures were removed, the remaining one removed two days later. Patient was permitted to get out of bed on the twenty-fourth day, and returned home on the thirty-first day, with the hernia apparently permanently cured.

Doctor Haynes remarked that the type of operation used in this case was one that he began using in 1911 and had continued to employ ever since in post-operative hernia, especially those of unusual size. The steps of the operation had been first described by him in the *New York State Journal of Medicine*, in December, 1913.

TETANUS FOLLOWING FRACTURE OF ULNA

HERNIA RECURRING AFTER MACEWEN OPERATION

Dr. Alexis V. Moschcowitz presented a patient who was operated by him for a recurrent inguinal hernia. The interest in the case centred around the fact that the original operation took place thirty-three years ago, at which period MacEwen's operation was the operation of choice. He wore a truss ever since his operation, but discarded it about four months ago, whereupon the hernia promptly recurred. The sac of the recurrent hernia showed a sort of fibrous ring at its neck, where it was apparently tied off; and in various other parts of the sac there were to be seen a number of cicatrices, just at those points where it was reefed in order to make the pad required for the MacEwen operation. Poupart's ligament and most of the other structures were, as might be expected, untouched.

TETANUS FOLLOWING UPON A FRACTURE OF THE ULNA AND DISLOCATION OF THE HEAD OF THE RADIUS

Dr. Alexis V. Moschcowitz presented a boy, seven years of age, who had been admitted to his service at Mt. Sinai Hospital April 11, 1917, with the history that one week ago he fell off a fence and injured his right forearm. Two days ago the arm became swollen, and this swelling was incised by his physician, under the supposition that it was an abscess. On admission there was found a large fusiform swelling surrounding the right elbow-joint; one and one-half inches below the elbow-joint there was an incised, infected wound, discharging a small amount of pus. The entire area was extremely tender, particularly over the ulnar aspect, where crepitus was also obtained. A prophylactic injection of 3000 units tetanus antitoxin (New York Board of Health) was given immediately on admission, and the arm put up with traction in extension.

On April 16, five days after admission, it was noted that the facies was suggestive of a risus sardonicus; the jaws could still be separated however. All reflexes were very active. All the muscles, particularly those of the back and abdomen, were rigidly contracted. Tetanic spasms of short duration occurred. Six thousand units of antitoxin were given. The usual treatment with bromides and morphine was also indicated. On the following day, April 17, the general condition was much worse. The jaws could be barely separated; one convulsion of three minutes' duration and several slight ones occurred.

Six thousand units antitoxin were then given subcutaneously, and in addition also 6000 units intraspinally, after a withdrawal of 30 c.c. spinal fluid. No tetanus bacilli were recovered from the wound culture, and mice injected with the spinal fluid on this and subsequent occasions all survived.

The condition was even worse on the following day, April 18. In the morning of this day 6000 units of antitoxin were administered intraspinally, without any notable effect. In the afternoon 2 c.c. of a 25 per cent. magnesium sulphate solution were injected intraspinally; whereupon the follow-

ing reaction was noted. The respirations became slower and occasionally there was also a sighing and yawning. For the first one and one-half hours the pulse was quite irregular. There was a complete relaxation of the entire musculature and no convulsions occurred, not even after artificial stimulation, which previous to injection always proved to do so. Three hours after the injection both the pulse and respirations were perfectly normal.

Slow improvement began with this one injection. We continued with the magnesium sulphate hypodermically, 1 c.c. being given every six hours. We also continued with the administration of antitoxin and antispasmodics. The symptom last to disappear was the one to appear first, namely, a local contraction of the right biceps upon the slightest irritation. All treatment as far as the tetanus is concerned was discontinued April 26, after the appearance of a very profuse urticaria. Thus far the gravity of the case prevented much attention being paid to the injured arm. As already stated, the fractured ulna was treated by extension and traction.

On May 1 examination revealed a more or less malunited fracture of the ulna in its middle, and a forward dislocation of the head of the radius. On May 2 an unsuccessful attempt at reduction of the dislocation was made by Doctor Brickner. The question now arose how soon it would be safe to operate for the dislocation of the radius without possibly stirring up dormant tetanus bacilli. It was decided to postpone operation for the time being. He was readmitted June 23; operation June 26, the head of the radius being resected. He was discharged cured July 7.

Dr. Winfield S. Schley referred to a case reported by him in 1904 of tetanus following a punctured wound just below the knee in a small boy, developing five days after the injury. At that time magnesium sulphate was not one of the adjuncts to the treatment, but intraneural, intraspinal, and subcutaneous injections of serum were used. The intraneural injections were very helpful; the spinal injections were subdural, not into the cord, the patient receiving altogether about 200 c.c. of serum. He made a very good recovery, although slow, but his progress, considering the unusual severity of a case developing so early after injury, was quite remarkable.

RETROPERITONEAL MYXOLIPOFIBROMA

Dr. Frank S. Mathews showed a patient that had presented no symptoms except abdominal enlargement. A very large soft tumor could be felt in the upper abdomen descending almost to the pelvis. It was thought most likely a cyst of the pancreas. Operation showed that it was retroperitoneal, extending to the diaphragm on the left side and downward into the mesentery of the descending colon. The spleen was displaced forward and the tumor was very intimately related with the left kidney, behind which it lay, and which was displaced forward so as to be in contact with the abdominal wall. The tumor was œdematous and proved to be a myxolipofibroma with possibly some sarcomatous transformation.

PNEUMOCOCCUS PERITONITIS

CHONDROMA OF ANTERIOR SURFACE OF ILIUM

Doctor Mathews then presented a patient, thirty-eight years of age, who applied for enlistment but was rejected and sent to St. Luke's Hospital because of a tumor filling the left iliac fossa, extending two inches above and to the right of the umbilicus well over into the true pelvis, up into the loin and under Poupart's ligament. It cast no X-ray shadow, was a pure chondroma and weighed between three and four pounds. Displacement of the iliac vessels caused the left extremity to swell. The first impression was that the tumor was inoperable; the second, that under no circumstances could it be removed with its capsule because of the certainty of injuring vessels and ureter in the pelvic wall, as well as the sigmoid flexure whose mesentery it invaded. It was, however, attacked by an incision above Poupart's ligament which extended directly into the tumor, with finger and curette. The entire tumor was removed intracapsularly. The peritoneal cavity was invaded at some places. Patient made an uneventful recovery. The swelling of the thigh has disappeared.

PNEUMOCOCCUS PERITONITIS

Dr. Parker Syms read a paper with the above title.

Dr. A. V. S. Lambert stated that at the Presbyterian Hospital there had been some cases of idiopathic peritonitis which on being studied bacteriologically proved to be of the pneumococcus variety. Last winter there was a particularly interesting group of cases: The father had pneumonia, was taken ill in his home in a tenement, taken from there to the Rockefeller Institute, where the pneumococcus Group I was isolated; two days later his daughter was taken ill in the same tenement, removed to the Rockefeller Institute, there diagnosed as appendicitis and sent to the Presbyterian Hospital, where she was operated on with a diffuse peritonitis from which was recovered the pneumococcus of Group I. Her blood was taken at the time of the operation, showing a bacteræmia, pneumococcus No. 1, and subsequently she developed a post-operative pneumonia of the same group. She was drained at the time of operation and suppurated rather profusely through the opening, and the nurse who took care of her developed a pneumococcic peritonitis, Group I, with a bacteræmia and a post-operative pneumonia. Both she and the child recovered of their peritonitis, both were treated with serum and both on the day prior to operation had a throat culture positive for pneumococcus No. 1. The nurse had the localized type of peritonitis, the child the diffuse type, which goes to prove that at least one group of pneumococcus will give both types of disease. Both developed a post-operative pneumonia, which is a very frequent, if not constant, sequel of pneumococcus bacteræmia in patients receiving ether as an anæsthetic.

Dr. George Woolsey referred to a case presented by him before the Society some years previously and recalled one or two other cases which had led him to write a paper upon this subject. He considered that there

were many interesting problems connected with this condition. He understood that Doctor Syms advised no operation for the diffuse form of peritonitis, advocating, if possible, waiting for the encysted stage. He did not consider it always easy to make a pre-operative diagnosis of pneumococcus peritonitis, although there are several features that are suggestive. With regard to diarrhœa, this sometimes accompanies appendicitis in children; again, high temperature may be an accompaniment of appendicitis, especially in children. He thinks that the diagnosis is not made until operation in the majority of cases. He had a case in which a leucocytosis of over sixty thousand suggested the diagnosis of pneumococcus peritonitis. At operation there is the odorless fluid with the fibrin and the typical color to help in the diagnosis. Doctor Woolsey doubted whether the non-operative treatment would present a better mortality rate than the operative, as he believed many cases had been reported where operation had resulted favorably.

He could offer nothing toward the solution of the question as to why this condition should occur more frequently in girls than in boys, since the pelvic organs so far have not been found to be a site of infection. In secondary cases the swallowing instead of the expectoration of the discharges might partly account for the high incidence in children, but not for the higher incidence in girls.

Dr. Howard Lilienthal stated that he had seen a number of these cases, had operated upon two, both female children, both of whom died; he had never seen a male child with this condition. Since these two fatal cases he had adopted the rule that whenever the pediatrician turned over to him a suspected case of pneumococcus peritonitis he advised against operation. He stated that he had operated upon one female adult in whom Friedlander's bacillus was isolated, a case of encysted peritonitis, the patient making a good recovery.

He asked whether pneumococcus peritonitis was the only form in which operation was not indicated, suggesting that acute gonococcus peritonitis be placed in the same category.

Dr. A. C. Whipple spoke of the bacteriology of the disease as found in the Presbyterian Hospital in the last two years, stating that this had been intensively studied in seven cases. Pneumococcus Group I was found in three and Pneumococcus Group IV in one. Two of the Group I cases recovered. In these cases, serum treatment was used. The other Group I died and the Group IV case died very promptly, having a diffuse form of peritonitis.

If the procedure is followed of injecting into a mouse some of the exudate from the peritoneum when the patient does not seem to have a diffuse peritonitis of intestinal origin, the diagnosis will be cleared up promptly, because the mouse will die within six hours of a pneumococcus bacteræmia. The isolation of pneumococcus can almost always be done within eight hours by this means, definitely proving to which group it belongs, and if to Group I the serum can be administered at an early stage.

He called attention to a point mentioned by Doctor Lambert, that if the sputum of the patient shows a Group I pneumococcus in the anti-operative examinations and if that patient should come down later with abdominal symptoms, the diagnosis would probably be more definite, because the presence of pneumococci in the sputum, especially the parasitic varieties I, II, III, is more apt to be found in the throat because of contact with other pneumonia patients. Laboratory methods, particularly with the mouse inoculation, make it possible to clear up the diagnosis in these cases much more rapidly and definitely than was formerly the case.

Dr. Nathaniel W. Green referred to a case of idiopathic peritonitis presented by him five years ago. It was a case of a little girl operated for appendicitis, but nothing was found to corroborate this diagnosis except the inflammation of the peritoneum. The exudate was cultured and proved to be streptococcus. Subsequent to operation the patient developed another collection of pus on the opposite side and microscopically and culturally this proved to be pneumococcus. He considered it probable, according to Rosenow's theory, this was the same infection in different stages.

Dr. John Douglas called attention to the fact that in a certain number of cases of pneumonia in children the first symptoms are abdominal and he considered it questionable whether a number of these cases of pneumonia affecting the lung are not in the beginning a general bacteræmia in which there is a certain amount of irritation of the peritoneum. In the last two years he has seen two cases with a diagnosis of appendicitis where there were no physical signs of pneumonia in the lung, but where an X-ray picture showed a beginning focus at the root of the lung extending upward, physical signs developing twelve to twenty-four hours later. He referred also to one child in whom a diagnosis of appendicitis was on three distinct occasions made, but before operation was instituted he promptly in each instance developed a pneumonia.

Dr. Parker Syms, in closing, stated that at Lebanon Hospital he found reports of eight cases of idiopathic peritonitis in which there had been a clinical or surgical diagnosis of pneumococcus peritonitis; three of these cases had not been examined bacteriologically. Of the five cases bacteriologically examined, three showed streptococcus and two showed pneumococcus. A point to be made is that an ordinary bacteriological examination is not enough to avoid mistake between streptococcus and pneumococcus. Unless the most elaborate tests are employed a definite decision cannot be reached.

As regards Doctor Lilienthal's question, the speaker stated that he had had no personal experience with idiopathic gonococcus peritonitis. Excepting this and peritonitis due to the streptococcus and pneumococcus, he believed all acute cases of peritonitis suitable for operation.

As to the difference in the types of the disease, namely, the encysted and the diffuse forms, he wished to state that probably none of the cases are encysted at first, but that some have a tendency to become encysted and that these

possibly represent a certain type of the disease; on the other hand, there are other cases that have no tendency to become encysted and which continue to be of the diffuse form. In cases of diffuse pneumococcus peritonitis he did not consider operation indicated; but he agreed with Doctor Woolsey that it was almost impossible to make a differential diagnosis unless confronted with a patient in an extremely depressed toxic condition, far beyond anything the abdominal symptoms would account for, where it may be seen that we are dealing with a systemic disease in which operation is contraindicated.

He agreed with Doctor Douglas that some cases of pneumonia showed marked symptoms of peritoneal irritation. In fact, in pneumonia cases in which there is no peritonitis evident, nevertheless it may be possible to obtain plate cultures of pneumococci from the peritoneum.

BOOK REVIEW

LES PLAIES DE GUERRE DU POUMON. Notes sur leur traitement chirurgical dans la zone des armées. By PIERRE DUVAL. Masson & Cie, Editeurs. Paris, 1917.

This little volume is well worth the careful attention of students of thoracic surgery. The author, speaking from a wide personal experience, reaches certain conclusions which from all viewpoints appear sound and reasonable. Duval's main contention is that the frightful mortality of war wounds of the lung, which he estimates all in all as nearly 50 per cent., can be greatly reduced by treating these wounds according to the old and well-tried surgical principles as applied to wounds of other parts of the body. Instead of the timid waiting for the condition to become worse, he believes that early and thorough operation should be the rule. The point is emphasized that these patients bear surgery well—on the whole, better than those wounded in the abdomen.

Omitting those who die immediately or in the first aid stations, this author, from a study of 3453 cases, not including his own, concludes that of the patients who are fortunate enough to reach some hospital behind the first aid station fully 20 per cent. die. He concludes that from 25 per cent. to 30 per cent. die in the *poste de secours*, where most of the fatalities are due to hemorrhage and mechanotraumatic asphyxia. None of these mortality figures take into account the deaths from the secondary suppuration—so apt to occur in a terrain where pathogenic flora abound like that of the Somme battles.

There is a tremendous difference in the mortality following artillery wounds as against rifle ball punctures—a difference amounting to the proportion of eight to one (Schmid). Indeed, modern bullet wounds of the lung are apt to be "benign"(!) unless a large vessel has been hit. In artillery wounds the presence of shell fragments, bits of clothing, and splinters of bone is prone to cause speedy and dangerous infection unless quickly removed. Bone fragments are particularly frequent in tangential wounds of the chest wall, but their presence should be suspected in every case complicated by fracture.

Not infrequently lesions of the opposite lung have been noted, the cause of which Duval ascribes to *contre coup*. Rupture of the visceral pleura of the other lung and even purulent pleurisy have been noted. Lefevre had a case in which after extracting a foreign body from the upper lobe the patient succumbed from gangrene and hemorrhage of the lower lobe of the same lung.

Chapter III deals with hemorrhage. As the title naively has it, "L'Hemorrhagie mortelle dans les plaies du poumon et son traitement chirurgical d'urgence." This slip is an indication of the extremely grave view which is taken of severe traumatic pulmonary hemorrhage. Imme-

diate operation is the only chance for saving life. Hæmothorax is usually inversely proportionate to the amount of external bleeding. And it must not be forgotten that wounds apparently not related to the chest may still cause thoracic bleeding. DePage saw a case in which the only external wound was in the arm. Many patients suffering from hemorrhage were apparently doing well at the *poste de secours* but quickly sank and died after transportation to the hospital. Duval believes, therefore, that in these cases operation to check bleeding should be performed near the place where the casualty occurred. Late hemorrhage may be accompanied by hæmoptysis but the latter phenonemon alone is rare. It sometimes occurs with pulmonary gangrene. True secondary hemorrhage as well as other dangerous complications may follow the retention of shell fragments in the lung. Obviously, external bleeding must be checked, but many good surgeons advise against early operations in the intrathoracic hemorrhages. Even so good a man as Hartmann fears "precipitate operation in the closed thorax cases." Duval, however, wisely advises early thoracotomy. It is quite as important to operate for hemorrhage here as it is to perform laparotomy for the dangerous intra-abdominal bleeding of ruptured ectopic gestation. Indeed, in the progressive hæmothorax we have the added danger of mechanical pressure.

In making the diagnosis the greatest care must be exercised in making the physical examinations, for these patients are apt to die very suddenly on slight exertion. Sitting erect for X-ray examination is out of the question. Porter and DePage have shown the diagnostic value of repeated observations of the blood-pressure. If the manometer shows a rapid fall, the need for operation is urgent. Duval believes that two-thirds of these desperate cases can be saved.

Shell wounds of the lung are prone to be followed by anaërobic infection of the effused blood, and the danger of lung infection is greatest when there is a small hæmothorax with the viscus adherent to the chest wall. Pulmonary abscess is to be expected around a foreign body or a spicule of bone. Lesions of one lung with suppression of function are frequently complicated by pneumonia of the opposite side and such opposite side infections are of grave import. Early extraction of the projectile tends to prevent this complication.

An interesting point brought out is the sensitiveness of the pleura to anaërobic infection and the comparative immunity of the lung itself to this same infection. He reasons, therefore, that the pulmonary wound should be closed promptly, thus attempting to seal off the lung-dwelling anaërobes from the pleural sac. The infection beginning in the fibrin and clots of the hæmothorax rapidly spread to the incoagulable sanguinolent fluid within the chest. Bacteriological studies of the exudate are valuable in determining the necessity for early operation. As a field laboratory method it has been found that milk mixed with the suspected fluid and then heated until the bubbles are driven off will act as an anaërobic medium.

Repeated puncture may be necessary to keep track of advancing infection.

Duval claims priority (December, 1916) in suggesting the immediate operative treatment of pulmonary wounds and applying the same surgical principles as obtain in wounds of other parts of the body. He calls attention to the grave dangers of pleural infections, drawing a parallel with peritonitis from injuries of the abdominal viscera.

The proper procedure consists in thorough exploration and inspection of the wounded lung with treatment according to the character of the injury. In "blind" wounds of the lung with no point of exit, removal of the fragment is practised with the aid of Röntgenoscopy. Pulmonary perforations are cleaned out by reaming with gauze strips and the tract closed by suture. Surface wounds are mechanically cleansed and the edges approximated with mattress sutures. Systematic exploration of the lungs is practised by withdrawing lobe after lobe from a wound made by widely resecting a rib and using a rib-spreading retractor. Both inspection and palpation are of value. Experiments in blood-pressure appear to demonstrate that in these war wounds of the lung shock is less pronounced than in wounds of the peritoneum. As in all branches of our art, the clinical judgment of the surgeon is all-important. Whenever possible, local anæsthesia should be employed. A widely opened thorax must be closed as soon as feasible, but in any event projectiles must be removed. A good, firm dressing with pressure will relieve the distress of "open thorax" so that the patient can be transported.

Duval objects to the use of differential chambers in these war wounds, because the lungs being constantly distended, exploration is greatly limited. Drawing the collapsed lung out of a generous thoracotomy permits of examination, lobe by lobe, just as abdominal viscera are drawn up to the wound and examiner. With the atelectatic lung this is simple—with distended lung impossible. Respiration and pulse are not as a rule seriously disturbed during this procedure, and blood-pressure has been shown to be less influenced in these thoracic operations than in laparotomies.

Spinal anæsthesia cannot be depended upon, and any inhalation anæsthesia Duval considers a factor which greatly increases the risk of operation. He regards immediate drainage of the pleura as unnecessary. Hæmostasis should be carried out by the usual method but packing should be a last resort. Pleural closure should be complete, and the retained air removed later by aspiration. This is considered preferable to blowing up the lungs by positive pressure at the close of the operation. Drainage had better be secondary, *i.e.*, instituted hours or days after the operation. During convalescence morphine is absolutely necessary. The patients, preferably reclining, should be segregated in a warm ward near the operation room.

There is an appendix which consists of case histories, with records of operations and postmortems as they illustrate the points made by the author. Also a brief study of certain phases of the bacteriology.

HOWARD LILIENTHAL.

CORRESPONDENCE

PAROVARIAN CYST IN A YOUNG GIRL

To the Editor of the Annals of Surgery.

Dear Sir:

Most references to parovarian cysts infer that they do not occur, or at least are not sufficiently large to be demonstrated or cause trouble before the age of sixteen, or especially before the menstrual function has been fully established. Like all pathological conditions, however, variations present themselves, and it is for this reason that I am reporting this more or less interesting case of a parovarian cyst in a girl just past her twelfth birthday.

The patient was a well-developed girl just thirteen years of age, who had always enjoyed perfectly good health, with history negative in every respect. Her menstrual periods were established nine months before, were regular and without any subjective symptoms.

About six months before she had an acute attack of pain in the abdomen, which lasted for several days and was followed by complete recovery, and she remained well until the present time, when she had a similar attack and was referred to me for surgical interference.

The general appearance of the abdomen was that of about a six months pregnancy, the tumor being quite movable with the attachment at the lower portion. The right side of the abdomen was very sensitive to pressure, especially in the region of the appendix. The tumor itself produced no marked symptoms on pressure.

Urine analysis was negative, heart normal, temperature 100°, with some variation each way, and pulse about 95, also with some variation. Blood count: Red cells, 5,800,000; white cells, 11,600; hæmoglobin, 95. Differential count, mononuclear leucocytes, .26; polymorphonuclear leucocytes, .74. Color index, 95.

Abdominal incision revealed an acute non-suppurative appendicitis and a parovarian cyst.

The cyst when delivered presented the usual characteristic appearance, viz.: the vascular wall, the long drawn out Fallopian tube stretched over its surface with the ovary crowded to one side, and, contrary to the usual condition of being fixed to the broad ligament, it had a pedicle attached to the parovarium long enough to be twisted on itself twice. The cyst was unilocular, it contained just a little over twenty-four hundred cubic centimetres of perfectly clear fluid of a slightly syrupy consistency and with a specific gravity of 1003 and contained a trace of albumin. No difficulty was encountered in its removal, the appendectomy followed, and the patient made a very good recovery and at this time, three months later, she is enjoying perfectly good health.

Charles E. Slagle, M.D.,
Alliance, Nebraska.

December 21, 1917.

THE HYPOCHONDRIAC TYMPANY SYMPTOM OF PERFORATED GASTRODUODENAL ULCERS

EDITOR OF THE ANNALS OF SURGERY:

I should like to call attention to the occurrence of a symptom in perforated gastric or duodenal ulcers which I believe is of aid in the differential diagnosis.

I refer specifically to a small area of localized tympany over the liver. It is found in the parasternal line between the inferior and superior borders of the liver. It is rarely larger in extent than the palm of one's hand. It is readily elicited by simple percussion.

Though it is generally admitted that obliteration of the liver dulness is an important symptom in this diagnosis, one must admit that it is infrequently found. On the other hand, I have found this area of localized tympany in a fair percentage of cases. I have operated on ten cases of acute perforations of gastric and duodenal ulcers. As the records are not immediately available, actual statistics cannot be given. It is my impression, however, that this symptom may be found in at least 50 per cent. of the cases. I am at a loss to explain its occurrence. As a pool of gastric or intestinal contents is often found in the region of the perforated ulcer, it seems possible that the escaped free air is driven upward to the dome of the diaphragm where its passage is then prevented by the falciform ligament of the liver. This, however, is purely speculation.

ANTHONY H. HARRIGAN,
New York.

January 3, 1918.

SUTURE OF WOUND IN FEMORAL ARTERY

EDITOR OF THE ANNALS OF SURGERY:

A young man, eighteen years of age, was brought to the Birmingham Infirmary by Drs. Finley and Yielding, January 7, 1917, with the history of an accidental stab of the lower inner side of the thigh just below Hunter's canal. There had been some bleeding and some clots had been removed by a slight enlargement of the skin wound.

When I saw him the circulation in the limb was good and the leg was only slightly enlarged. We decided that there was probably an injury of some muscular branch with bleeding into the tissues, and put him to bed with his foot elevated. He improved and was asking to be sent home, when on January 24 he began to suffer violently and the leg became considerably swollen at this point. The following day, with a tourniquet around the upper part of the thigh, a long incision was made over the course of the Sartorius muscle, which was dissected up; the heavy fascia beneath was very tense, and, on being incised, a false aneurism three or four inches long beneath it was found, together with a wound in the femoral artery a third of an inch long. The wound in the artery was closed with six interrupted chromic catgut No. 1.

When the tourniquet was removed no bleeding occurred. The Sartorius muscle was then sutured down over the arterial suture line and the cavity obliterated with catgut. A tube drain was placed in the upper end of this cavity and the rest of the wound closed. The foot of the bed was elevated and hot water bottles applied to the foot and leg.

The circulation was normal from the time of operation. He was kept in bed two weeks, and then was allowed to go home on crutches, which he soon discarded. At the end of five months Dr. Yielding reports him perfectly well and doing hard work on his farm.

GASTON TORRANCE, M.D.,
Birmingham, Ala.

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